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## PHYSICAL AND CHEMICAL CHARACTERISTICS OF GHAZALLAT REGION, SIWA OASIS, WESTERN DESERT, EGYPT

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### ABSTRACT

Siwa Oasis is a closed depression situated in the north western portion of the Western Desert of Egypt between Longitudes 25° 16' and 26° 12' E, and Latitudes 29° 06' and 29° 24' N.

Three soil profiles were selected to represent the main geomorphic units and their associated soil groups in the studied area.

Ghazallat soils are characterized mainly by sand and sandy loam textures, as well as sandy clay loam in the deeper layers.

The chemical analyses of soil solution indicate that the cultivated soil samples show slightly saline to moderately saline nature, whereas the soils under reclamation and the barren ones are strongly saline. In general the organic matter contents are low, while CaCO<sub>3</sub> content increases from the deeper samples to the higher ones. As for the soil reaction of Ghazallat area, it is clear that these soils are ranging from mildly to moderately alkaline. It is noticed that Na<sup>+</sup> cation > Mg<sup>++</sup>, Ca<sup>++</sup> and Mg<sup>++</sup>. The predominance of Na<sup>+</sup> and Mg<sup>++</sup> is a good reflection of the involvement of marine origin of the soils. On the other hand, the anionic distribution has the following descending order Cl<sup>-</sup> anion > SO<sub>4</sub><sup>-2</sup> > HCO<sub>3</sub><sup>-</sup>, where CO<sub>3</sub><sup>-2</sup> is almost negligible. The distribution of the fertility elements are of low to moderate levels.

The bulk samples analysis indicates that quartz, calcite, feldspars (albite) minerals are the main dominant mineral associations in all soil profiles of Ghazallat region. Dolomite and anhydrite as well as gypsum presented in some depths of soil profiles. Illite and kaolinite represent the identified clay minerals in the studied soil samples.

The radiometric studies show that all of the studied soils in the area are not related to the uraniferous soils (uranium content not exceeding 6ppm).

### INTRODUCTION

It is well known that Egypt area is about one million square kilometer, mainly of desert lands with the exception of a small cultivated area concentrated in the River Nile Valley and Delta, occupying about 4% of the whole Egypt area. Therefore, there is a sever need to expanding the cultivated area either vertically or horizontally. There are some cultivated areas dominate the Egyptian oases of the West-

ern desert. One of these oases which are now under investigation is Siwa Oasis. Siwa Oasis is about 980 km<sup>2</sup> in area, only 6% are now under cultivation, while the bed rock of the area is mainly saline or occupied by salty lakes. It has certainly the most interesting, touristic attraction of all the Egyptian Oases due to its Ancient Temple and the largest naturally flowing springs, however it suffers from several problems such as continuous deterioration of

its cultivated lands mainly due to drainage problems.

The origin and geomorphologic features of Siwa depression as well as the other depressions of the Western Desert of Egypt was discussed by a number of workers, Hume (1952), Zein El-Abdein (1952), Ibrahim (1952), Metwally (1953), Said (1962), Parsons (1963), El-Askary (1968), Gindy and El-Askary (1969), Saleh (1970), Abu El-Izz, (1971), Zakaria (1972), Harga and Hammad (1975), Gomaa, (1976) and Abdel Sammie (2000).

### AIM OF THE WORK

In order to comprehend the main pathways of horizontal and vertical agricultural expansion, physical and chemical characterization of Ghazallat region soils of Siwa Oasis have to be fully investigated. Accordingly this requires studying the physical, chemical, mineralogical and radioactive properties of soils and its ability to provide the necessary nutrients for the plants.

### PHYSICOGRAPHIC FEATURES

#### Location

Siwa Oasis is a closed depression situated in the north western portion of the Western Desert of Egypt between Long. 25° 16' and 26° 12' E, and Lat. 29° 06' and 29° 24' N. The depression floor lies at 18 m above sea level and located at about 300 km southwest of the capital of Marsa Matruh Governorate Fig. (1).

The concerned depression is bounded in the north side by an escarpment rising about 100 m above the depression floor and by another escarpment in the southern side that is relatively lower than the northern one, but differs from it in that it is covered with sand dunes, trending NW-SE direction. The lowest parts of the depression floor reach 18m below sea level. From the west to the east, the depression floor rises gradually to merge with

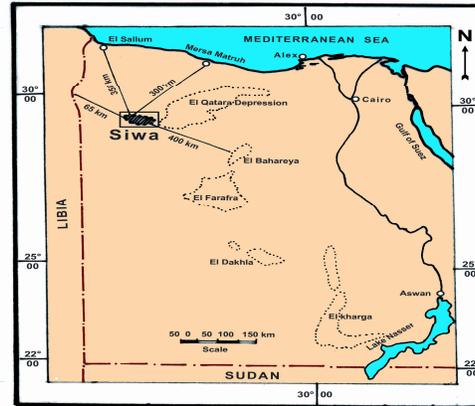


Fig.1: Location map of Siwa Oasis, Egypt

the general desert level, making it difficult to define clearly the western and eastern boundaries.

#### Soils

Soils of Siwa Oasis were studied by many workers, among them Zein El Aabedein (1952), Saleh (1970), Harga and Hammad (1975), Fanous (1979), Gomaa (1976) and Sherif (1979). Accordingly, the morphological and physico-chemical properties of these soils are mainly related to the parent materials forming the successive horizons of soil profiles. However, soils may differ with regard to their texture and lime (calcium carbonate) content, where the soils are formed as a result of weathering processes (both chemical and mechanical weathering) undertaken on limestone and country rocks. Consequently calcareous materials were transported and deposited by water and wind actions. Moreover, the sandy texture mostly dominating the soil profiles is due to wind action on dunes. On the basis of the geomorphologic features of Siwa Oasis, Harga and Hammad (1975), defined the following soil groups: 1- The sandy soil which are mainly found at zero contour line in the form of the crescent shape. These soils are also characterized by their shallow to medium depth, high water table and highly salt affected. 2- Deep sandy soils which are mainly located between the southern scarp and the main depression.

These soils are slightly calcareous ( $\text{CaCO}_3$  below 10%) and non-saline. 3- Saline soils occupying an appreciable portion of the depression and partly covered with a thick salt crust. The water table in these soils depends on their elevation and, more or less at about 100 cm deep. 4-Calcareous soils, which are mainly located in the eastern and western parts of the oasis. They are shallow to medium in depth, and highly salt-affected.  $\text{CaCO}_3$  content varies between 10 to 50% of the total soil matrix. 5-Hydromorphic saline sandy soils, which are mainly located at the shore-line of the old lakes. Profiles of such soils are shallow and extremely affected by salts.

Soils of Siwa Oasis can be differentiated into:

-The uncultivated soils: These include low lying areas (more than 15 m below sea level) of sabkhas that are highly salt affected as well as the soils which are close to sand dunes and those occupying the rocky areas.

-The cultivated soils: These soils are located between contours zero and -10 m above sea level.

## MATERIAL AND METHODS

### Field Work

On the basis of the obtained geomorphic information, interpretation of uncontrolled aerial photographs of scale 1:40.000 and geological map of scale 1:100.000, the soil samples were collected. Three soil profiles were selected to represent the main geomorphic units and their associated soil groups in the studied area, (Fig.2). These profiles were dug to about 150 cm depth from the surface except when rocky substrata or bedrock interfere.

### Soil Analysis

Grain size distribution was determined according to the international pipette method of Piper (1950). Gravel, sand, silt and clay fractions were separated by sieving and sedimentation after removal of cementing materials. Clay and silt were separated by wet sieving from sand using 0.63 mm sieve. The clay and silt were transferred to one liter cylinders for pipette analysis.

### Chemical Analyses

The chemical analyses include: 1-Total

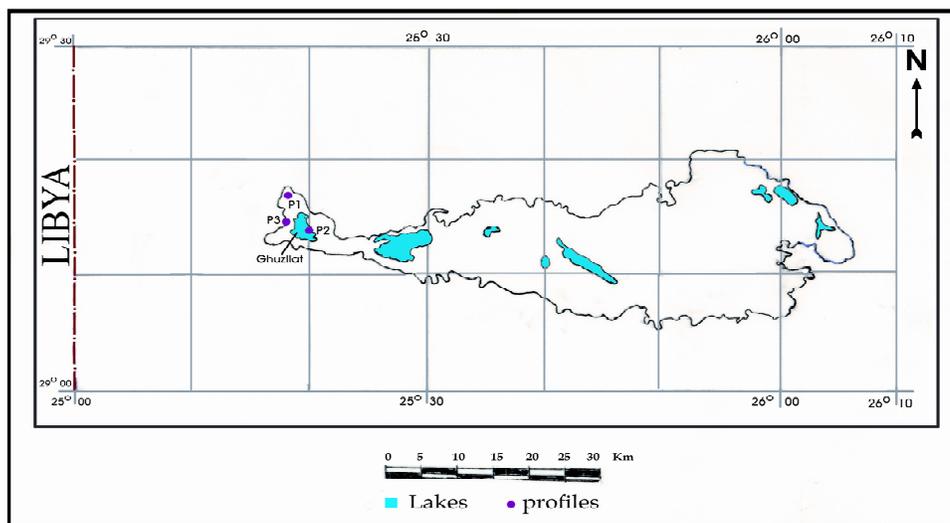


Fig.2: Location map of soil profiles, Siwa Oasis

soluble salts determined conductimetrically in the saturated soil paste extract using the solubridge.

2- Calcium carbonate content was determined volumetrically by Collins Calcimeter, (Piper, 1950). 3- Gypsum was determined by using the acetone method (Nelson, 1982). 4- Soil pH was measured in the soil saturation paste, (Richard, 1954). 5- Organic matter was determined according to Walkely and Black rapid titration method of Piper (1950). 6 - Total salinity (TDS) was determined through measurement of the electric conductivity in the soil extracts. 7- Cations ( $\text{Ca}^{++}$ ,  $\text{Mg}^{++}$ ,  $\text{Na}^+$  and  $\text{K}^+$ ) were determined by flame photometry 8- Anions  $\text{CO}_3^-$ ,  $\text{HCO}_3^-$ , and  $\text{Cl}^-$  were determined titrimetrically, but Sulphate ( $\text{SO}_4^-$ ) was calculated by difference. 9-Total nitrogen was determined by the macro-Kjeldahl apparatus as outlined by Piper (1950). 10-Avaliable P, K, Fe, Mn, Zn, and Cu were determined using ammonium bicarbonate and DEPA as an extracting solution, (Soltanpour and Schwab, 1977).

#### Mineralogical Analyses

1- Oriented clay samples were prepared from the separated clay as Mg-saturated air-dried, Mg-saturated glycerol solvated, K-saturated air dried and K-saturated heated to 550°C for 2 hours.

X-ray diffraction technique, (XRD), was used to identify the unknown minerals using PHILIPS PW 3710/31 diffractometer, scintillation counter, Cu-target tube and Ni filter at 40 kV and 30 mA. This instrument is connected to a computer system using X-40 diffraction program and ASTM cards for mineral identification.

Semi-quantitative estimations of identified minerals were then undertaken by measuring the under peak area as outlined by Norrish and Taylor (1962).

2- The bulk soil samples were prepared as unoriented powder mounted on glass sample holders for XRD analysis. Silt was scanned from 2 to 60 two theta degrees, (Zussman,

1977).

#### Radiometric Analyses

1- The radiometric study was carried out in the field by using the handling Eberline Smart Portable (ESP-1) instrument, which counts the total gamma rays emitted from the various rocks in counts per second (cps).

A multi-channel analyzer gamma ray spectrometer was used to determine the eU, eTh and Ra concentrations in the laboratory. The system consists of NaI-Tl Bicron scintillation detector connected with NE-4658 amplifier and a high voltage power supply with HV digital display.

All of these analyses were carried-out in Nuclear Materials Authority laboratories (NMA).

### RESULTS AND DISCUSSION

Several major regions are distinguished in Siwa depression; the most important one is Ghazallat region. This region borders the oasis from the west inside El-Maraqui sector. It has many olive and palm grove gardens that are supported their irrigation water from springs and shallow wells.

#### Textural Classes

Ghazallat soils are characterized by textures mainly of sand and sandy loam as well as sandy clay loam in the deeper layers (Table.1).

The soils are also characterized by massive, structures, soft; non-sticky; non-plastic; moderately calcareous and involving many fine roots. This region includes three types of soils; the cultivated soils, soil under reclamation and barren soils. In this region, three soil profiles were dug and intensively studied in the field and the main characteristics features of the different soils are discussed in the following paragraphs:

#### The Cultivated soils

Topographically, these soils are almost flat with gentle sloping. Soil colour ranges from

very pale-brown (10YR 7/4, dry) to light yellowish-brown (10YR 6/4, moist) in the uppermost and middle layers, while the deepest one have pale-brown (10YR 6/3, wet) colour. Soil profile (No.1) representing those soils. Soil texture ranges from sandy in the upper layer and becomes gradually sandy clay loam in the lower one.

Table 1: Particle size distribution and textural classes of the studied soil profiles of Ghazallat region

P. No.	Type of soil	Depth (cm)	Sand %	Silt %	Clay %	Textural Class
P (1)	Cultivated soil	0-100	85.62	10.49	3.89	S
		100-200	85.63	10.84	3.51	S
		200-250	58.35	19.81	21.84	SL-SCL
P (2)	Soil under reclamation	0-30	65.20	21.55	15.25	SL
		30-50	59.10	20.30	22.60	SL-SCL
		50-120	41.25	30.31	28.44	CL
		0-40	89.22	8.29	2.49	S
P (3)	Barren soil	40-80	79.50	17.80	2.70	LS
		80-200	56.90	17.10	26.0	SCL

S=Sand, SCL= Sandy clay loam, SL= Sandy loam, CL= Clay loam, LS= loamy sand

### Soils under reclamation

Topographically, these soils are gently undulating, very gently sloping and are dominated by black colour (10 YR2/1) in the surface layers changing to olive gray (5Y 5/2, moist) in the deepest one (profile No.2). Soil texture ranges from sandy loam in the surface layers gradually changing with depth to SL,SCL and CL (Table.1).

### Barren soils

The morphological description of this type of soils shows that these soils are characterized by drift sand surface. The average thickness of the barren soils is more than 150 cm and imperfectly drained. Soil colour differs from very pale-brown (10YR 8/4) to light brownish gray (10YR 6/4) in dry condition, changing to yellowish-brown (10YR 7/4) in the moist one. Generally, the soils are composed of coarse-grained sand changing into Sandy clay loam with depth and sandy clay loam in some layers.

A detailed description of these soils is given in profiles No. 1, 2 and 3 (Tables 2, 3 & 4)

### Physical and Chemical Properties of the Studied Soil Profiles

The physical and chemical analyses of the studied soil profiles in Ghazallat region (Tables 5 & 6) will discuss in the following paragraphs:

#### Total salinity

The approximate limits of salinity classes were defined in the Soil Survey Staff Manual (1951), Table (7).

As shown in Table (5), electrical conductivity of the soil saturation extracts (EC) of cultivated soils at Ghazallat region ranges from 4.60 up to 12.20 dS/m<sup>-1</sup> at 25°C in the deepest

Table 2: Detailed description of soils in profile No. 1 (Cultivated soils)

Location	Lat. 29° 18' 03" E and Long. 25° 19' 09" N
Slope	Nearly level
Topography	Almost flat
Vegetation	Cultivated mainly with olive and palm trees (old farm)
Surface cover	Aeolian sand over weathered limestone
Drainage	Poorly drained
Depth (cm)	Description
10-100	Very pale-brown (10YR 6/4, dry) to light yellowish brown (10YR 6/4, moist) sand; massive, soft slightly sticky, non plastic; slightly-calcareous; abrupt smooth boundary.
100-200	Light yellowish-brown (10YR 6/4, moist) sand, non-sticky, non-plastic, slightly calcareous, abrupt smooth boundary.
200-250	Pale-brown (10YR 6/3, wet), sandy clay loam; massive, soft, slightly sticky, slightly plastic; slightly calcareous.

Table 3: Detailed description of soils in profile No. 2 (Soil under reclamation)

Location	Latitude 29° 13' 08" E and Longitude 25° 20' 09" N,
Slope	Gently sloping
Topography	Gently undulating,
Vegetation	Non-cultivated,
Surface cover	Non-cultivated,
Drainage	Imperfectly drained
Depth (cm)	Description
0-30	Black (10YR 2/1, moist) sandy loam, coarse sub-angular blocky, sticky, slightly plastic and friable; few fine soft lime segregations; few fine to medium roots; common fine spots of decomposed organic matters; abrupt smooth boundary.
30-50	Black (10YR 2/1, moist) sandy clay loam, coarse sub-angular blocky, sticky, slightly plastic and friable; few fine soft lime segregations; few fine to medium roots; common fine spots of decomposed organic matter; abrupt smooth boundary.
50-120	Olive gray (5Y 5/2, moist) clay loam, coarse sub-angular blocky, very sticky, very plastic, common fine soft lime spots and segregations; common stains of iron oxides; few fine dead roots.

layers falling in slightly saline to moderately saline class with specific trend throughout the soil depth. The soils under reclamation are extremely strong saline as indicated from EC values (range from 30.0 dSm<sup>-1</sup> up to 47.50 dSm<sup>-1</sup>). It is noticed that salinity increases gradually to the surface denoting the effect of evaporation upon drying. The barren soils are strongly saline (EC values range from 46.40 dSm<sup>-1</sup> up to 56.50 dSm<sup>-1</sup>).

#### Organic matters and calcium carbonate contents

Organic matters content in the cultivated soils ranging from 0.35% to 2.25% (Table.6), this is due to the continuous burying of the palm trees residues. Also, the organic matters content is low in soils under reclamation, (not exceed 0.52%), while the barren soils have prevailing aridity so, they characterized by an

Table 4: Detailed description of soils in profile No.3 (Barren soil)

Location	Latitude 29° 15' 01" E and Longitude 25° 19' 30" N
Slope	very gently sloping
Topography	Undulating
Vegetation	Scattered Hallophytes
Surface cover	Aeolian sand over weathered limestone
Drainage	Imperfectly drained
Depth (cm)	Description
0-40	Very pale-brown (10YR8/4, dry) to pale-brown (10YR 7/4 moist) sand, non-sticky, non-plastic and loose; few fine to coarse residual roots; diffuse smooth boundary.
40-80	Very pale-brown (10YR7/4, moist) loamy sand, massive; sticky, plastic and firm ; extremely strong reaction with HCl; common medium sand pockets; few fine black spots decomposed organic matters; clear smooth boundary.
80-200	Very pale-brown (10YR7/4, moist) sandy clay loam, massive; sticky, plastic and firm ; extremely strong reaction with HCl; common medium sand pockets; few fine black spots decomposed organic matter.

Table 5: Physical analyses of soil profiles, Ghazallat region.

Profile No.	Type of soils	Depth (cm)	S.P %	pH	EC dS/m at 25°C
P (1)	Cultivated soil	0-100	27.40	8.00	4.60
		100-200	22.00	7.7	9.90
		200-250	23.30	7.8	12.20
P (2)	Soil under reclamation	0-30	46.45	8.00	47.50
		30-50	43.20	7.5	44.30
		50-120	30.00	7.8	30.00
		0-40	45.40	7.1	46.40
P (3)	Barren soil	40-80	55.50	8.10	56.50
		80-200	36.40	8.8	51.44

negligable amounts of organic matter ranging from 0.03% to 0.08%, since the high temperature and dry climate encourage the rapid decomposition of organic matters.

Table 6: Chemical analyses of soil profiles, Ghazallat region

Profile No.	Depth (Cm)	CaCO <sub>3</sub> % CO <sub>3</sub> <sup>2-</sup>	Anions (mg/L)				Cations (mg/L)				O.M %
			HCO <sub>3</sub> <sup>-</sup>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>	Ca <sup>++</sup>	Mg <sup>++</sup>	Na <sup>+</sup>	K <sup>+</sup>		
P (1)	0-100	29.13	-	4.54	79.84	41.54	26.73	16.42	80.50	2.27	0.39
	100-200	32.90	-	3.47	63.53	32.90	19.35	13.30	65.02	2.23	0.35
	200-250	34.65	-	2.43	24.38	12.25	4.85	2.98	30.03	1.20	2.25
	Average	32.23	-	3.48	55.92	28.90	16.98	10.90	58.52	1.90	0.37
P (2)	0-30	22.34	-	2.19	351.67	150.26	65.29	58.58	370.95	9.30	0.34
	30-50	43.35	-	3.76	318.33	147.85	55.45	46.65	360.96	6.88	0.51
	50-120	47.90	-	2.13	190.50	119.05	43.42	42.99	218.79	6.48	0.52
	Average	37.86	-	2.69	274.83	139.05	54.72	49.41	316.9	7.55	0.47
P (3)	0-40	16.95	-	3.60	324.61	170.24	63.53	93.73	320.09	21.10	0.15
	40-80	14.70	-	3.76	408.36	204.85	65.10	61.94	470.83	19.10	0.06
	80-200	19.10	-	2.45	8.35	5.88	3.23	0.95	11.85	0.65	0.03
	Average	16.92	-	3.27	247.11	126.99	43.95	52.21	267.59	13.62	0.08

Table 7: Classification of saline soils, (Soil Survey Staff Manual, 1951).

Class	Class Name	EC dSm <sup>-1</sup> at 25°C
0	Salt Free	0-4
1	Slightly Saline	4-8
2	Moderately Saline	8-15
3	Strongly Saline	>15

Calcium carbonate (CaCO<sub>3</sub>) values range from 29.13% to 34.65% in cultivated soils, profile (1), but from 22.24% to 47.90% in soils under reclamation, while they range from 14.70% to 19.10% in the barren soils (Table.6). The soils therefore are highly calcareous.

The enrichment of CaCO<sub>3</sub> in the subsurface horizons of cultivated and under reclamation soils is apparently not pedogenic as these soils are young and usually under wet conditions.

**Soil reaction**

Table (5) shows that the soil reaction of the cultivated and under reclamation soils is mildly to moderately alkaline (pH values range from 7.1 to 8.00) . The barren soils are characterized by a highly alkaline as indicated from pH values which range from 7.1 to 8.80 (Table.5).

**Cationic and anionic composition**

Soluble calcium (Ca<sup>++</sup>) is often dominating cation followed by Mg<sup>++</sup> and Na<sup>+</sup> cation, while K<sup>+</sup> is the least soluble cation in all profiles. We can be notice that Na<sup>+</sup> cation > Mg<sup>++</sup>, Na<sup>+</sup> > Ca<sup>++</sup> and Mg<sup>++</sup>. The predominance of Na<sup>+</sup> and Mg<sup>++</sup> is a good reflection of the involvement of marine origin of the soils formation. On the other hand, the anionic distribution has the following descending order Cl<sup>-</sup> anion > SO<sub>4</sub><sup>2-</sup> > HCO<sub>3</sub><sup>-</sup>, where CO<sub>3</sub><sup>2-</sup> is neglected (Fig.3). This indicates that sodium chloride is the predominant salt followed by calcium sulphate.

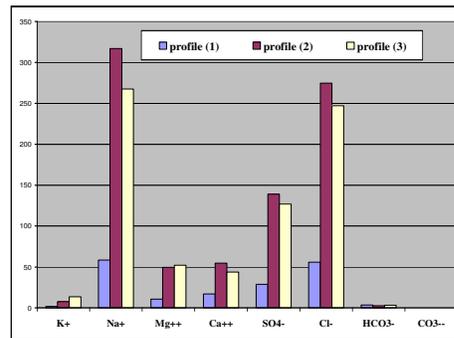


Fig. 3: Averages of cations and anions variability bar diagram (in mg/L) of soil profiles, Ghazallat region

**Distribution of Fertility Elements (NPK)**

According to Okalebo et al., (1993), the values of total nitrogen in cultivated soils in Ghazallat region (profile No.1) indicate low to moderate levels (range from 0.09% up to 0.16%, (Table.8).

Available phosphorous content ranges from 7.22 ppm to 12.0 ppm, while potassium

Table 8: Distribution of fertility elements of soil profiles, Ghazallat region.

P. No.	Type of Soil	Depth (cm)	Total N %	P (ppm)	Fe (ppm)	Mn (ppm)	K (ppm)	Zn (ppm)	Cu (ppm)
P (1)	Cultivated soils	0-100	0.16	12.0	20.44	17.30	332	2.56	2.25
		100-200	0.13	8.35	12.6	22.1	408	2.20	2.43
		200-250	0.09	7.22	12.4	18.05	327	2.10	2.10
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P (2)	Soils under reclamation	0-30	0.19	7.12	44.90	20.12	689	2.30	2.50
		30-50	0.08	3.90	28.56	3.89	720	2.40	1.26
		50-120	0.09	2.13	35.10	2.10	558	2.50	1.17
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P (3)	Barren soils	0-40	0.19	3.68	2.60	0.29	102	0.79	0.20
		40-80	0.04	2.34	2.36	0.06	270	0.59	0.08
		80-200	0.05	2.43	3.40	0.40	126	0.86	0.09

ranges from 327 ppm to 408 ppm. Iron, manganese, zinc and copper elements occur in adequate levels (Table.8).

According to Soltanpour and Schwab (1977), the studied soils have an adequate level of iron, manganese and copper, while zinc is present in low to adequate levels.

In the soils under reclamation (profile No.2), it is clear that total nitrogen exhibits low to moderate levels (0.08% to 0.19%), (Table.8). Phosphorous ranges from moderate level in the surface layer to very low level in the sub-surface layer (7.12ppm to 2.13 ppm) to adequate levels (4.66 ppm to 14.89 ppm), while available potassium has high levels (558 ppm to 720 ppm). Available iron, manganese, zinc and copper are present in adequate levels ranging from (28.56 to 44.90 ppm), (2.10 to 20.12 ppm), (2.30 to 2.50 ppm) and (1.17 to 2.50 ppm) respectively.

Concerning soil fertility in the barren soil of Ghazallat region (profile No.3), we can be noticed that, the total nitrogen occurs in low to moderate levels as its values vary widely from 0.05% to 0.19%. Available phosphorous ranges from very low to moderate levels, while available potassium has moderate to high levels (102

ppm to 270 ppm). Available iron is found in the marginal levels (2.36 ppm to 3.68 ppm), while available manganese is found in low to adequate levels ranging from (0.06 ppm to 0.40 ppm). Zinc is present in low levels (0.59 ppm to 0.86 ppm), while copper is found in very low amounts, not exceeding 0.20 ppm.

### Mineralogical Composition

#### Mineralogical composition of bulk soil samples

Total soil samples (bulk samples) and oriented clay fractions were analyzed using X-ray diffraction technique in order to evaluate aspects of soil genesis and formation.

Analyses of the bulk soil samples led to identify the essential minerals in the studied profiles. X-ray analysis data of some soils from Ghazallat region are listed in (Table.9) and Figs. (4 and 5).

The obtained data indicates that quartz, calcite, feldspars (albite) minerals are the main dominant mineral associations in all soil profiles of Ghazallat region. Dolomite and anhydrite as well as gypsum are present in some depths of soil profiles.

Quartz gives diffraction line at 4.26 besides a strong second order peak at 3.34Å.

Table 9: Mineralogical composition of the bulk soil samples of the studied soil profiles

P. No.	Depth (Cm)	Quartz	Calcite	Albite	Dolomite	Anhydrite	Gypsum
P (1)	0-100	*	*		*		
	100-200	*	*	*	*		
	200-250	*	*	*			
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P (2)	0-30	*	*	*			*
	30-50	*	*	*		*	*
	50-120	*	*	*			
<hr/>							
P (3)	0-40	*	*	*	*	*	*
	40-80	*	*	*	*	*	*
	80-200	*	*	*	*		

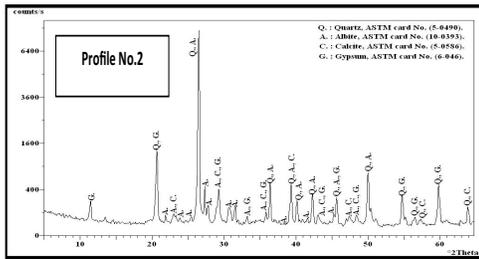


Fig.4 : X-ray diffractogram of quartz, albite, calcite and gypsum minerals from soil profile (No. 2) from Ghazallat region

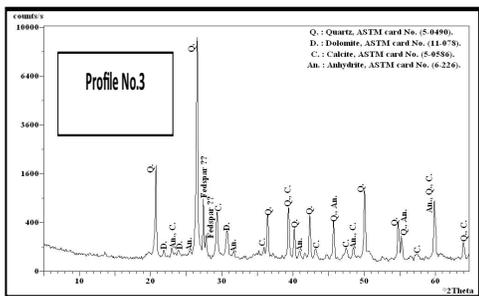


Fig. 5: X-ray diffractogram of quartz, dolomite, calcite and anhydrite minerals from soil profile (No.3) from Ghazallat region

The diffraction doublets about 3.22 to 3.24 Å beside an overlapped peak at 4.25 Å denote the presence of feldspars.

Calcite ( $\text{CaCO}_3$ ) is a carbonate mineral and also the most stable polymorph of calcium carbonate. The other polymorphs are the minerals aragonite and vaterite. The peaks at 3.03 Å and the relatively weak one at 2.49 Å confirmed the presence of calcite in all samples of the soils of Ghazallat region.

Albite ( $\text{NaAlSi}_3\text{O}_8$ ) is a plagioclase feldspar mineral. It is the sodium end member of the plagioclase solid solution series.

Dolomite  $\{\text{Ca Mg}(\text{CO}_3)_2\}$  is a carbonate mineral composed of calcium magnesium carbonate. Dolomite mineral is identified by the presence of broad peaks at 2.89 Å, 2.19 Å and 1.79 Å, respectively Anhydrite is a mineral - anhydrous calcium sulfate ( $\text{CaSO}_4$ ).

Anhydrite is most frequently found in evaporite deposits with gypsum and associated with calcite, halite and sulfides

Gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) is a very soft mineral composed of calcium sulfate dihydrate. It is often associated with halite and sulfur minerals.

Based on the foregoing presentation of soil mineralogy, we can conclude that the occurrence of quartz, feldspars and dolomite may be referred to the nature of parent materials forming the soils in Ghazallat region. Here, it is worth to mention that the dominance of quartz relative to feldspars is attributed to susceptibility to weathering.

### Clay fractions analysis

X-ray diffraction analysis of the clay fractions that separated from the studied soil profiles of Ghazallat region is shown in (Table. 10) and (Figs. 6, 7, and 8). Interpretation of X-ray diffraction patterns is based on the presence of characteristic diffraction peaks for each mineral in the clay sample. The criteria used for clay mineral identification are those mentioned by Brown (1961), Jackson (1973), Dixon and Weed, (1977) and Wilson, (1987).

For further differentiation, semi quantitative estimation of the identified minerals was performed. The data of the semi quantitative mineralogical composition of the clay fraction are shown in (Table.10). It is clear that illite and kaolinite represent the identified clay minerals in the studied soil samples.

Illite  $(\text{K}, \text{H}_3\text{O})(\text{Al}, \text{Mg}, \text{Fe})_2(\text{Si}, \text{Al})_4\text{O}_{10}(\text{OH})_2(\text{H}_2\text{O})$  represents the dominant mineral (Figs.6, 7 and 8) in all of the studied soil profiles in Ghazallat region. It gives a diffraction peaks at 9.96 Å to 10.28 Å in the Mg-saturated samples and remains constant in the other treatments. Admixture of quartz is characterized with high sharp peak at 3.35 Å through all treatments.

Illite is non-expanded clay-sized micaeous mineral. It is a phyllosilicate or layered

alumino-silicae. Structurally, illite is quite similar to muscovite with less potassium and more water .

Kaolinite and illite occurrences are reported by Hammad and Harga (1976) in a study of the soils of Siwa Oasis. Beside these two minerals, palygoeskite was identified. The former mineral was attributed in the study to

Table 10: Semi quantitative estimation of the clay minerals composition.

Profile No.	Depth (Cm)	Kaolinite	Illite
	0-100	++	+++
P (1)	100-200		++
	200-250	++	++
P (2)	0-30	++	+++
	30-50		+++
	50-120		++
P (3)	0-40	++	+++
	40-80	+	++
	80-200		+

+, 5-15% ; ++, 15-30% ; +++, 30-50% ; ++++, 50-70%

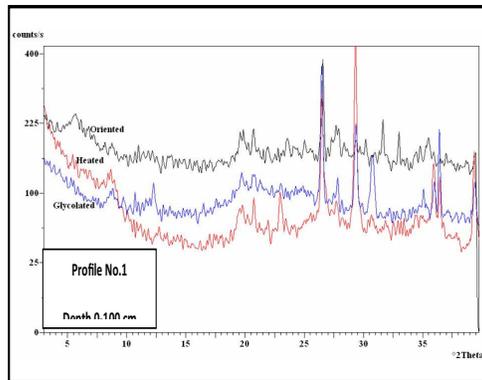


Fig. 6: X-ray diffraction pattern of  $< 2\mu$  clay fraction separated from profile No. (1), showing illite and Kaolinite minerals, Ghazallat region

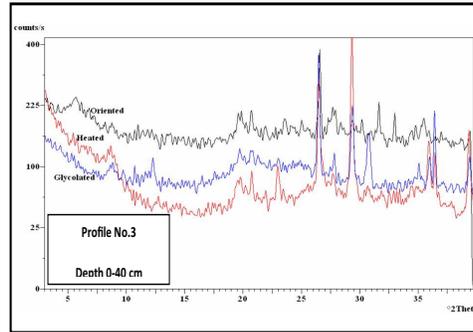


Fig. 7: X-ray diffraction pattern of  $< 2\mu$  clay fraction separated from profile No. (3), showing illite and Kaolinite minerals, Ghazallat region

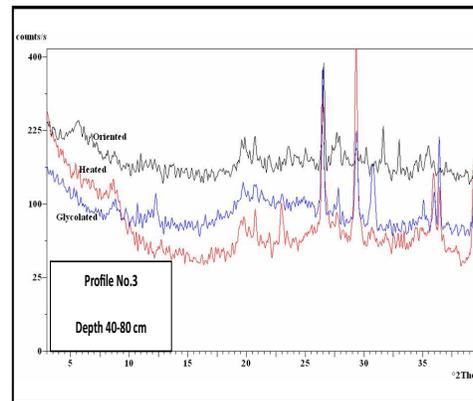


Fig. 8: X-Ray Diffraction Pattern of  $< 2\mu$  clay fraction separated from profiles No. (3) showing illite and kaolinite minerals, Ghazallat region

a calcareous and brine environments.

Kaolinite is formed in soils under acid wet conditions which is not prevailing under the present environment in Siwa Oasis. The soils there are formed due to weathering of the exposed rocks in the depression encouraged by a high water table. Kaolinite can be contains very small traces of U and Th, therefore, useful in radiological dating.

Kaolinite gives a strong spacing at 7.16 Å and 3.57 Å in the Mg-saturated samples and disappear upon heating to 550°C for four hours.

### RADIOMETRIC STUDIES

However, uranium seems to be more easily leached than its daughter  $Ra^{226}$  and than  $Th^{232}$ , (Baweja et al., 1987). Soil surveyors do not include in their activities information about their radioactivity levels. It is very important to establish criteria to define elevated concentrations in the agricultural environment, (Arkipovet et al., 1986, Drichko and Lisachenko, 1984, Talibudeen, 1964 and Graham, 1964).

Charters et al. (1991) reported that the highly weathered soil near uranium mine would have relatively high uranium content because of their small contents of clay, organic matters, iron content as well as acidic pH values. They (Op. Cit.) reported variable values for uranium content in soils ranging from less than 1 ppm to 8 ppm. Then, they concludes that any soil has average uranium content more than that average can be called as uraniferous soil. IAEA, (1988) reported also that some specific plants tend to accumulate uranium (U) as well as selenium, (Se), and sulphur, (S).

### Distribution of Uranium and Thorium

The studied soil profiles were analyzed using gamma-ray spectrometric techniques for measuring their uranium, thorium and radium contents.

Table (11) shows the  $eU^{238}$ ,  $eTh^{232}$  and  $Ra^{226}$  contents as well as  $eTh/eU$  ratios of the studied soil profiles from Ghazallat region. Profile (P.1) has an  $eU$  average content reaching 2.67 ppm, an average  $eTh$  content of 5 ppm and average  $Ra$  content of 1.89 ppm, while the average of  $Th/U$  ratio is 1.87. Profile (P.2) has average  $eU$ ;  $eTh$  and  $Ra$  contents reaching about 4, 33 ppm, 7.67 ppm and 3 respectively, with an average  $eTh/eU$  ratio of 1.77. The average  $eU$  contents in profile (P.3) is 3.67 ppm, the average of  $eTh$  content is 7 ppm and the average  $Ra$  content is 2.67 ppm, while the average  $eTh/eU$  ratio is 1.90.

These means that all of the studied soils in the area are not related to the uraniferous soils (not exceed 6ppm of uranium content).

### Uranium and Thorium Relationships

The relationship of uranium against thorium may clarify the enrichment or depletion of uranium and/or thorium. The plotting of  $eU$  against  $eTh$  of selected samples (Fig.9) shows a positive relation. All of the studied samples plot in the field of  $eTh/eU$  greater than 1 (Table.11), which means the depletion of  $eU$  relative to  $eTh$ . We can be noticed that, there are no any accessory minerals bearing uranium or thorium as well as no any secondary uranium minerals in such samples due to the depletion on their contents of  $eU$  and  $eTh$ . These means that, all of the studied soil samples are not related to uraniferous soils.

Normally,  $eTh$  is three times as abundant as uranium in natural rocks (Darnely, 1982). When this ratio is disturbed, it indi-

Table 11:  $eU$ ,  $eTh$  and  $Ra$  Contents as well as  $eTh/eU$  Ratio of Soil Samples from Ghazallat Region.

Profile No.	Depth (Cm)	$eU$ (ppm)	$eTh$ (ppm)	$Ra$ (ppm)	$eTh/eU$
P (1)	0-100	3	5	3	1.67
	100-200	2	4	2	2.00
	Average	2.67	5	2.67	1.87
P (2)	0-30	3	7	3	2.33
	30-50	4	8	3	2.00
	Average	4.33	7.67	3	1.77
P (3)	0-40	4	7	2	1.75
	40-80	3	6	3	2.00
	Average	3.67	7	2.67	1.90

$eU = ^{238}U$ ,  $eTh = ^{232}Th$ ,  $Ra = ^{226}Ra$

cates the depletion or enrichment of eU. This is very evident in the analyzed soil samples of all types (cultivated soils, soil under reclamation and barren soils), where the increasing in eTh/eU ratios is accompanied by depletion in uranium, hence a negative relation exists. So, the variation diagrams (Figs.9 and 10) indicate that all of the studied soil samples are very poor in the radioactive elements which cause very harmful diseases.

### CONCLUSIONS

Ghazalat area represents one of the most promising parts of Siwa Oasis for agricultural development because of it covers wide area with good topography and low relief, sand and

sandy loam as well as sandy clay soil texture. In the same time, its soils contain some illite and kaolinite clay minerals and variable elements that are necessary for agriculture as K, Ph, N, Zn and Ca with different values and the irrigation water are also available. The study clears that the development of the area needs to adding some natural as well as artificial fertilizers.

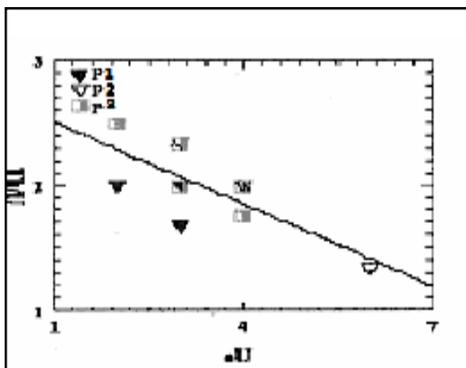
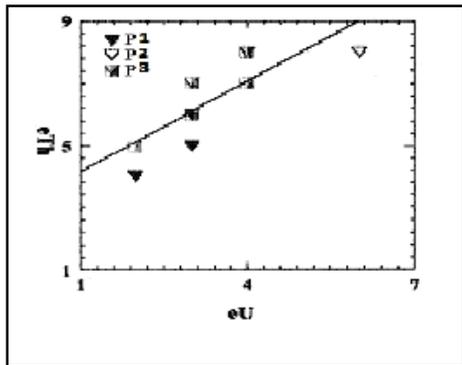


Fig. 9: eU-eTh binary diagram of soil samples and eU-eTh/eU variation diagram for soil samples Ghazallat region.

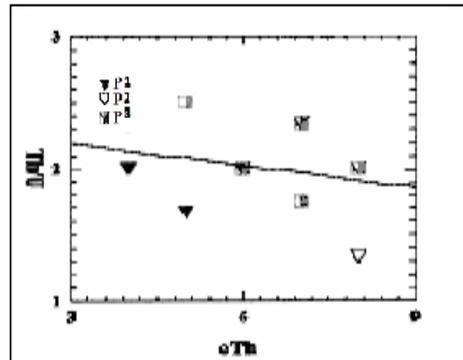


Fig. 10: eTh-eTh/eU variation diagram for soil samples, Ghazallat region

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### الخواص الطبيعية والكيميائية لمنطقة غزلات، واحة سيوه، الصحراء الغربية، مصر

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واحة سيوه أحد منخفضات الصحراء الغربية و هي منخفض مغلق يقع في الجزء الشمالي الغربي من الصحراء الغربية المصرية بين خطي طول ٢٥١١٦ و ٢٦١١٢ شرقاً و خطي عرض ٢٩١٠٦ و ٢٩١٢٤ شمالاً.

تم اختيار ثلاثة قطاعات للدراسة من تربة منطقة الغزالات ممثلة للوحدات الوصفية والمكونات الأساسية التابعة لهذه التربة ومن خلال الدراسة تبين أن هذه التربة تتميز بالنسيج الرملي والرمل الجيري بالإضافة الى النسيج الرملي الطيني الجيري وبخاصة في الطبقات العميقة في هذه القطاعات.

وقد أوضحت التحليلات ان تربة منطقة غزالات ثلاثة انواع وهي تربة صالحة للزراعة و تربة قابلة للإستصلاح وتربة غير صالحة للزراعة. يتميز النوع الاول من التربة انها ذات طبيعة قليلة الملوحة الى متوسطة الملوحة بينما عينات التربة القابلة للإستصلاح وعينات التربة الغير صالحة للزراعة تتميز بأنها شديدة الملوحة. وكذلك وجد أن محتوى المواد العضوية في التربة قليل بينما محتوى كربونات الكالسيوم يزيد وخاصة في الطبقات العميقة من هذه القطاعات.

كما وجد أن طبيعة هذه التربة تتراوح في قلويتها من قليلة الى متوسطة وانها غنية بعنصرى الصوديوم والماغنسيوم مما يكون انعكاساً جيداً على أن هذه التربة ذات أصل بحري.

وقد وجد أيضاً من خلال التحليلات الكيميائية أن مجموعات العناصر المخصبة (NPK) تتراوح من مستويات قليلة الى متوسطة.

كذلك دلت الدراسات المعدنية على أن التربة محل الدراسة غنية بمعادن الكوارتز والكالسيت وبعض الفلسبارات (الألبيت)، كما تم العثور على معدنى الدولوميت والأنهيدريت بالإضافة الى معدن الجبس في بعض الطبقات العميقة من القطاعات. ومن خلال تحليل وفصل معادن الطين بواسطة التحليل الحيوى الذى اوضح وجود معدنى الألايت والكاولينيت

وقد دلت ايضا الدراسات الإشعاعية أن جميع أنواع التربة المدروسة لا تنتمى الى التربة المشعة حيث لا يتجاوز المحتوى اليورانيومى بها عن ٦ جزء من المليون.