Mineralogical Aspects in Relation to Origin and Uniformity of Soils of Wadi Watir Basin, Southeastern Sinai, Egypt

Farag, F. M. *, M. A. A. Hassan *, Kh. I. Khalil and A. D. Abd-El- Latif ****
* Suez Canal University, Faculty of Agriculture, Soil and Water Department, 41522 Ismailia, Egypt
** National Research center, Ministry of Agriculture, Dokki.

Received: *20/5/2008*

Abstract: Nine soil profiles were chosen to represent the soils of the main soils associated with the different landforms of Wadi Watir basin. Heavy minerals suite were separated from the very fine sand fraction. X-ray diffractograms of the clay fractions of some soil profiles were obtained. Data of constituent minerals were used to evaluate soil genesis and degree of heterogeneity of these soil profiles. Results revealed that heavy minerals of the fine sand fraction are detected as opaques, pyroboles and epidotes in high amounts. Zircon, rutile, tourmaline and staurolite are present, but in relatively moderate amounts, while the remaining minerals are found in less pronounced amounts. The general mineral assemblage and the uniformity ratios of Zr/T, Zr/R and Zr/R+T as well as the weathering ratios (W_1= P+A/Z+T, W_2= H/Z+T and W_3= B/Z+T) are taken as criteria for soil genesis and uniformity. The data show that soils of the studied Wadis are non-uniform due to the heterogeneity of the parent materials or multi-depositional regimes. The data also show that these soils are recent from the pedogenises of view.Mineralogical composition of clay fraction suite in studied area is dominated by Smectite (Montmorillonite), Kaolinite, Chlorite, vermiculite, Illite, Palygorskite, Sepiolite and Mixed layer of clay minerals. Furthermore, some non clay minerals e.g. quartz, feldspars and calcite are detected in considerable amounts in some clay samples. The origin of the clay minerals is discussed.

Keywords: Heavy minerals, Clay minerals, Soil genesis, Weathering Ratios and Parent material.

INTRODUCTION

Wadi Watir is the most important and promising basin drainage in southeastern Sinai. It is located between latitudes 28° 46' and 29° 33' N and longitudes 33° 53' and 34° 44'E covering an area of approximate 3500km^2.

The character and compsition of material from which a soil is derived, i.e. parent material, is of a particular importance in areas of low precipitation, where severre leaching does not occur and evaporation dominates. The effect of different parent materials persist over very dry periods of time so that the lithology, texture and mineralogy of the parent rock always dominate as basic soil profile differences. The study of the minerals of the sand fraction could be used as a tool to evaluate soil profile uniformity and its development, as well as soil genesis in terms of the degree of mineral weathering, (Brewer, 1960 and Bear, 1964). Moreover, the cholice of index minerals and its ratio to evaluate uniformity and origin of parent material was used for along time by a number of workers, (Humbert and Marshall, 1943; Polnov, 1944; Lotti and Averna, 1968). In addition to, the studied of clay fraction is vital importance to throw light on the nature and types of clay minerals which strongly affect the soil fertility and development. Therefore, the current work in this investigation is a trail to identify the mineralogical composition of the sand fraction and clay minerals of some soil profiles represent the geomorphological units of Wadi Watir basin. Data obtained are used to evaluate the genesis and uniformity of these soils.

MATERIAL AND METHODS

Thirty nine soil samples were collected from nine soil profiles representing the main geomorphological units and landform in the Wadi Watir basin in the southeastern of Sinai Peninsula (Fig. 1).

After the ordinary pretreatments was achieved according to Jackson (1975). The very fine sand fraction (0.063 - 0.125mm) was separated from each sample by dry sieving.

The separation of heavy and light minerals was carried out following the procedure described by Brewer (1964), where separating funnel containing bromoform (Sp. gr. 2.84 $\pm$ 0.02) as a heavy liquid was adopted. Then the heavy and light minerals were washed with alcohol, dried and mounted on glass slides using gum tragacanth and Canada balsam according to the method given by Brewer (1964). The systematic identification of the light and heavy minerals was carried out using the optical properties as given by Milner (1962).

The clay fraction was separated by the method of Jackson (1975). Soluble salts were removed by continuous dissolution with water; calcium carbonate was removed by NaOAC (pH 5) and organic matter by H_2O_2. The free iron oxides were removed by citrate-bicarbonate dithionite method. The clay was investigated using oriented aggregate air dried on glass slides. Three treatments were carried out for each clay sample, Mg-saturated air dried, and Mg-saturated glycerol and heated to 550'C for 4 hours, which were investigated by X-ray diffraction using Philips PW 1730 Cuk and Radiation.

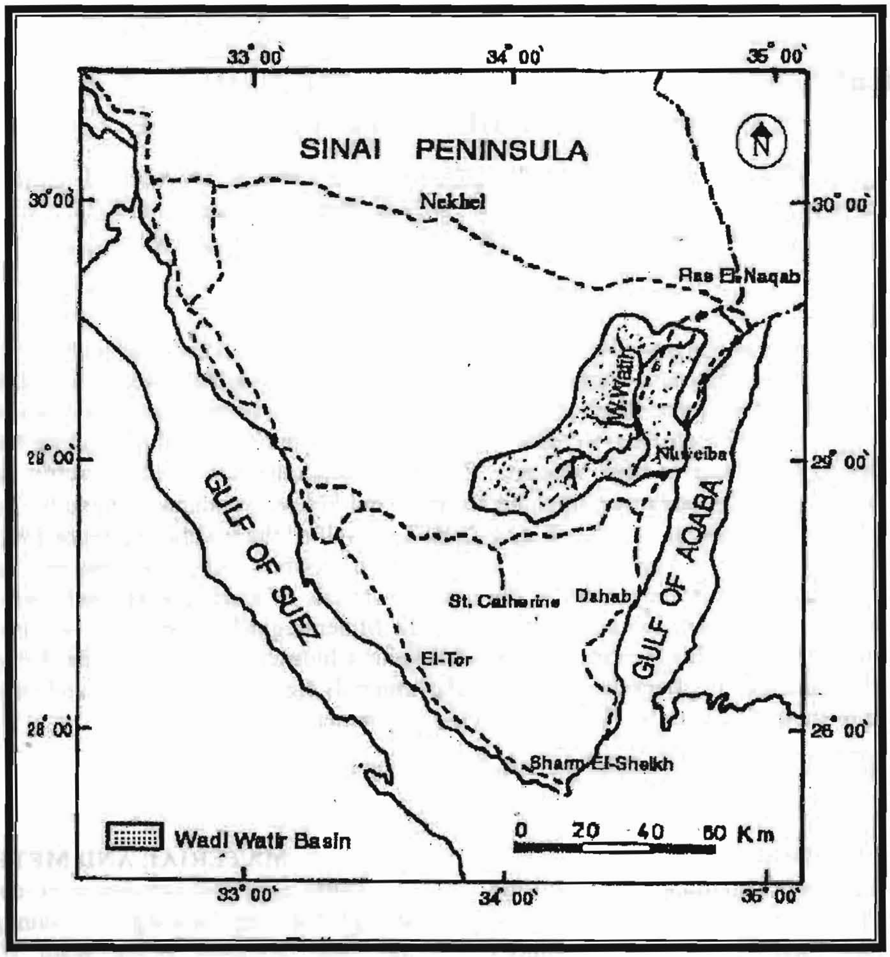


Fig (1): Location map of Wadi Watir study area in southeastern of Sinai Peninsula

RESULTED AND DISCUSSION

In general, the main constituents of heavy fraction are opaque and non-opaque minerals. Amphiboles, Pyroxenes, Zircon, Epidotes and Opaque minerals are present in main constituent amounts, while, Tourmaline, Rutile, Staurolite, Biotite, Garnet, Kyanite and other minerals etc. are present in subordinate amounts. Their frequency distribution is illustrated in Table (1) in which non-opaque constituents were considered as 100%. However, the opaque percent ages are also recorded. The results indicate that opaque minerals besides Pyroxenes, Zircon and Rutile are the most abundant minerals. Biotite, Tourmaline, Garnet and Andolusite were presented in relatively moderate amounts, while remaining minerals were found in less pronounced amounts.

1-Opaque minerals:

The opaque minerals were examined alternatively by transmitted reflected light and configuration, as shown in Fig (2 A and B) and could classify into block opaque (magnetite and illuminate, coloured opaque hematite and limonite).

The frequency distribution opaque minerals were ranges from (41.1 and 54.3%) recorded in profile 1 and 6 (at depth 70-120cm and 30-45cm, respectively) showing no vertical or lateral trend in the studied area. The geomorphic units content of the opaque can be arranged according to the follow order: recent wadi terraces > pediment plain > delta > wadi bottom.

2-Non opaque minerals:

The non opaque minerals are those formed at the some time with the rock in which they occur. Mineral associations detected are described in the following:

Amphiboles:

Amphibole minerals are represented mainly by Hornblende which is found in three verities, olive green, bluish green and dirty bottle green. In a decreasing order of abundance Hornblende occurred as prismatic and tabular grains with rounded edges and motley displays pleochroism from pale to dark shades. The Actinolite was recorded in a fibrous form with faint pleochroism. Amphiboles are recorded in all samples examined but vary widely. These minerals were ranges from 12.1 to 47.1% in studied soil sample. The high frequency distribution of Amphiboles recorded in recent terraces wadi.

Pyroxenes:

Pyroxenes group less abundant than Amphibole group with frequency, which was ranged from 8.1–29.7%, table (1). Both the ortho and clinopyroxine members are present, while the latter is being more abundant, Fig (3a). The dominant variety in the study area is Augite followed by hypersthenes and/or dioposide. Augite is present a yellowish green, greenish yellow, prismatic with sub-rounded edges in fig (3b). In conclusion, the abundance of amphiboles and pyroxenes in the study soils generally indicate recent and poorly developed soils that were inherited mostly from southern Sinai basement rocks (igneous and metamorphic).

Epidotes:

Epidotes are hydrous calcium iron silicates which crystallize in the monoclinic system. These minerals are recorded in all of the examined samples but with low quantities ranges from 0.5% to 5.1% of the non-opaque minerals and are mainly represents by Pistachite. The pistachite grains are pale green, yellowish green, subrounded forms and brownish yellow in color. The distribution of Epidotes in the study soils area indicates a metamorphic or hydrothermal source rocks. The high frequency of these minerals distributions are in wadis bottom geomorphic unit.

Biotite:

Biotite is present in all of the examined soil profiles, its frequency varied from 0.5 to 18.8%, table (1). It occurs mainly as reddish brown, yellowish brown and brown flaky varieties with common opaque minerals inclusions, show that in Fig (4 A and B).

Zircon:

Zircon is the most abundant ultrastable mineral. This mineral is found in all examined soil samples. It is present as colorless grain with high relief, pale gray bipyramidal and pyramidal termination with inclusions, Fig (5A and B) However; few sub-rounded grains without inclusions are presented. Distinct trend depth wise in the geomorphic units were not distinguished.

Rutile:

Rutile is a titanium dioxide (TiO2) which crystallizes in the tetragonal system it is considered as the second abundance ultrastable mineral in all the studied soil profile samples. The frequency of Rutile varies from 4.8% to 13.4. Rutile grains are recorded as reddish color with rod-shaped and sub round edges in the profile No 5 and 2 at depth 0-18cm and 11-35cm, respectively. Show that in Fig (6 A and B).

Tourmaline:

Tourmaline mineral is a complex boron silicate. This mineral represents the third abundance ultrastable minerals in the studied soil samples. It was recorded in all the examined samples at amounts varied from 1.2 to 5.3%. Tourmaline grains showed different color varieties, e.g. pale brown, green brown, yellowish green and green. However, brown and yellowish brown are the most common varieties, Fig (7 A and B). It occurs as prismatic with sub-rounded edges and characterized by exhibiting strong pleochrism.

Garnet:

Garnet is one of the most common metamorphic minerals in the studied soil profile samples. These minerals are present as brown, colorless yellow or as green with sub-rounded edges, isotropy under the cross nicols and pitted surface, Fig (8 A and B). Its content ranges between 1.1 and 5.5%. The highest frequency recorded in recent terraces wadi and minimum recorded in old terraces wadi geomorphologic units.

Staurolite:

Staurolite was occurs in sub-angular grains and frequency between 0.5 to 7.0%. It was crystallizes in the orthorhombic system and having a brown or golden yellow colors with different inclusions.

Andalusite:

Andalusite is detected as colorless to faintly yellowish plaeochroism sub-angular or prismatic grains with rounded to sub-rounded edges, Fig (4A). The frequency distribution of Andalusite is range between 0.8 and 8.6%.

Sillimanite:

Sillimanite is recognized as colorless longer prismatic or rectangular grains with irregular terminations and distinct vertical striations. The minimum and maximum values of Sillimanite are ranged between 0.5 and 7.0%, which recorded in profiles No. 5 and 9 in old terraces wadi and delta geomorphologic units, respectively.

Kyanite:

Kyanite is recorded in all the examined soil samples but with low frequency. It is represented by prismatic colorless angular to sub-angular grains and characterized by typical cleavage. Its values ranged from 0.5 to4.6% in recent terraces wadi samples.

Environmental Provenances of sand fractions:

The difference and random fluctuations in the distribution of heavy minerals associations are mainly attributed to the variation in the nature of provenance and the environmental of deposition. The study area is receiving sediments derived from mainly two important provenances that are:

1- The first provenance of parent material is dominated by igneous and metamorphic rocks (Southern Sinai basement rocks) which contribute more Amphiboles, Pyroxenes, Epidotes and metamorphic minerals.
2- The second provenance of parent material is dominated by sedimentary rocks (mostly Cretaceous Sandstone) which are rich in ultrastable (Zircon, Rutile, Tourmaline) and Biotite minerals.

In conclusion, the sources of sand fractions in the study area are a mixture of basement and sedimentary rocks. This conclusion is confirmed by the distribution of calcium carbonate in the study soils as well as the types of gravel in the different profiles. (Mixed of basement, calcareous and chest gravels).

Uniformity of soil material:

To evaluate the origin and degree of heterogeneity of the parent materials from which the studies soils were derived, Brewer (1964) mentioned that weathering reduces the less resistant minerals (pyroboles, epidotes and Biotite) and has little or no effect on more resistants (zircon, rutile, tourmaline, garnet and Kyanite). This can be elucidated by a decrease of less stable and ultrastable minerals. Hammed (1968) used the ratios Z/T, Z/R and Z/R+T, as well as weathering ratios, as criteria for the evaluation of profile uniformity and weathering sequence for the sediments.

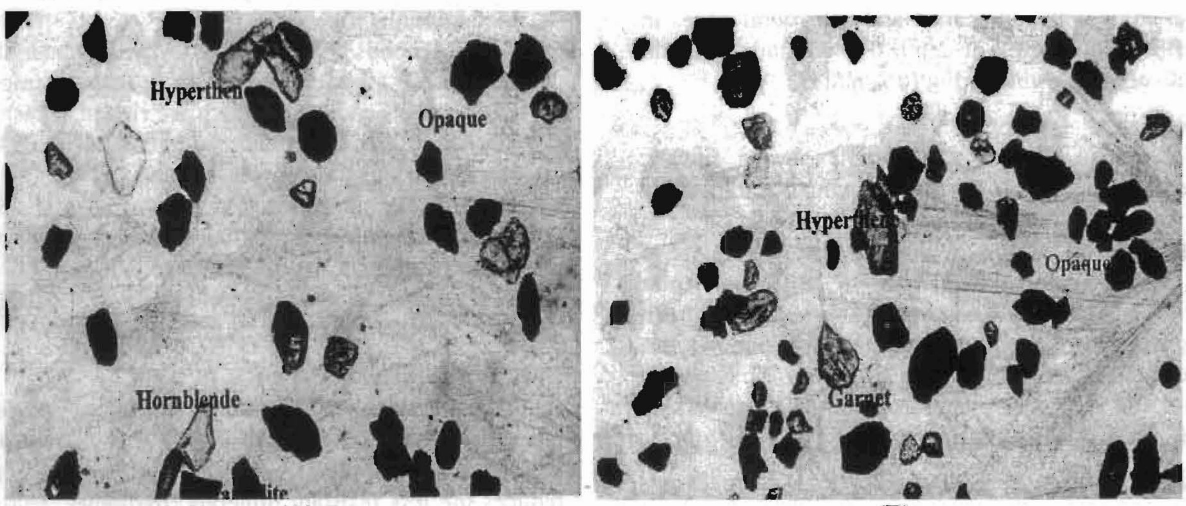
The data obtained for the different layers of the studied soil profiles are presented in Tables 2. The application of the ratios Z/R, Z/T and Z/R+T (Table 2) for each soil profile reveals that all soils of the studied area are of multi-origin or formed due to a multi-depositional regimes as indicated by the patterns of frequency distribution. The data reveal that the highest values are found in the upper layers of most of these profiles. This could be due to either contamination with other sediments of different nature to relatively per-supposition to decay. Exceptions being noticed in the soil Profile No. 2 and 3 in the soils of wadi bottom which have apparent slightly homogeneity with slight differences which could be rendered mainly to the sedimentation processes.

Weathering index ratios, i.e. W_1, W_2 and W_3, calculated for the different layers, of each soil profiles, provide a fairly good confirmation of the results obtained from ratios between resistant minerals (Table 2). It is clear that most of the studied profiles do not portray any specific trend of weathering ratios. Variations in weathering ratios with depth for each profile, as well as from profile to another, may be attributed to the fast that these soils are of multi-origin or being developed under multi-depositional regimes.

Mineralogical composition of clay fraction:

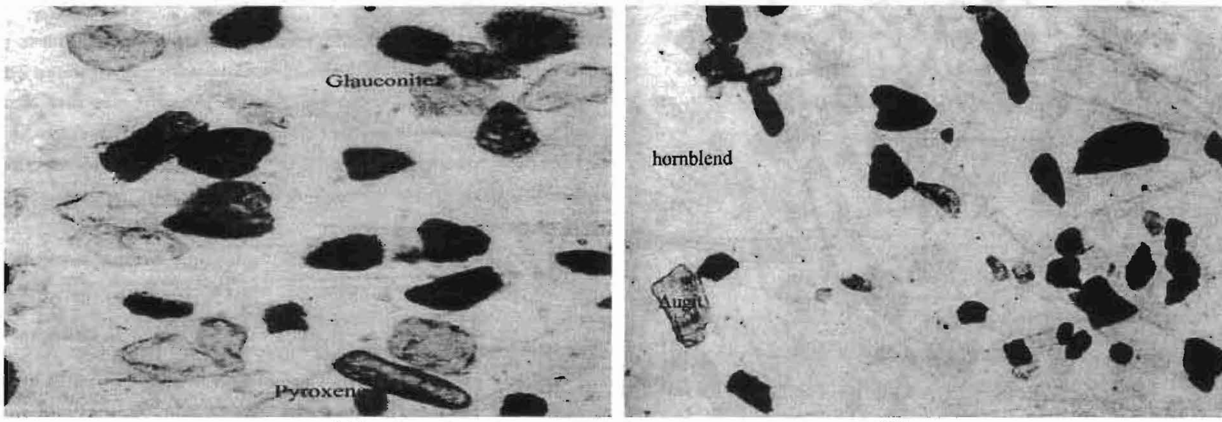
Studying the mineralogical composition of the clay fraction is of vital importance to throw light on the nature and types of clay minerals which strongly affect the soil fertility and development. The X-ray diffractograms (XRD) of clay fraction of some soil profiles representing dominated geomorphological units in the studied area were obtained. The results in Table (3) and Figs (9 A, B, C and D) revealed that Smectites are the predominant clay minerals as evidenced by the expansion of 14.7 - 15.2A° diffraction peak of Mg-saturated samples to about 17.6 to 18.1A° upon glycerol treatment Kaolinite and Chlorite showed their peaks at 7.1 and 14.0A° respectively in all soil samples. Illite tends to occur with traces quantity in all soil samples.

The XRD data of clay indicate the presence of a peak at 10.5A° which might point to the presence of Palygorskite. This confirmed by presence of diffraction peak at 6.4A°. Sepiolite is usually associated by palygorskite in all soil samples. It's identified by characteristic diffractions at about 12.1A° and confirmed by 7.47A°. These peaks are rat affected by glycerol treatment but disappeared by heating at 550°C for two hours. It may be believe that the occurrence of Palygorskite and Sepiolite in these soils appear to largely inherited from the parent material rather than the pedological significance. The data also show that the interstratified minerals constitute few to traceable amounts in the different land forms. The presence of the interstratified minerals of different patterns, mostly expanding and nonexpanding 2: 1 type indicate a transitional stage during the weathering sequence of sediment. The presence of potassium feldspars, quartz and calcite is indicated from the existence of their respective diffraction peak at 3.24A°, 3.35A° and 3.04A°. The distinctive accessory minerals in all studied soil samples are generally ascribed to their resistance during the course of sedimentation. As to the origin of the obtained clay minerals and their relation to the prevailing environmental conditions in the studied area, i.e. arid climate condition, scanty in vegetation and the calcareous nature, it seems that all the material. Moreover, the slightly differences in such minerals with profile depth are mainly due to lithological discontinuity. However, some alteration and weathering occurred during less and periods in the past could have participated in the formation of the present minerals.



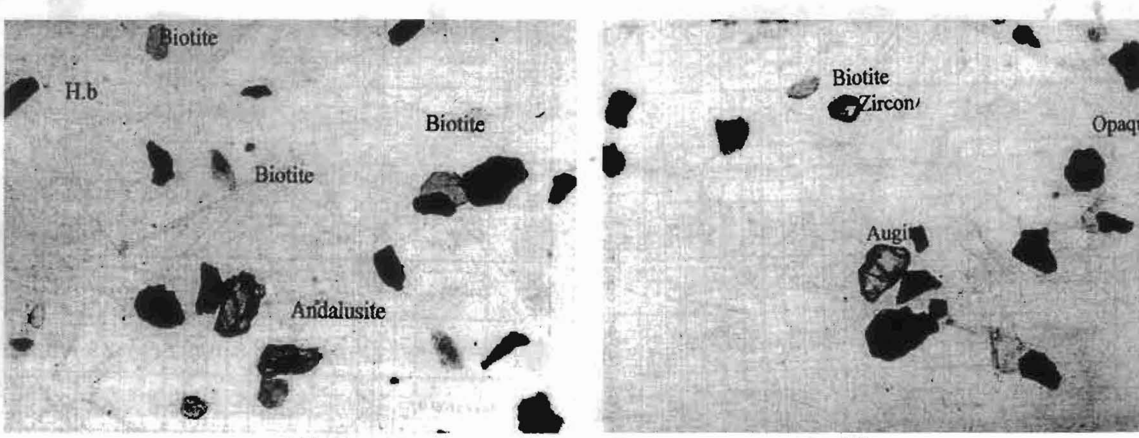
(A) (B)

Fig (2 A and B): Photomicrograph of Opaque minerals grains and other non opaque minerals between crossed-nicols (Profile No. 4).



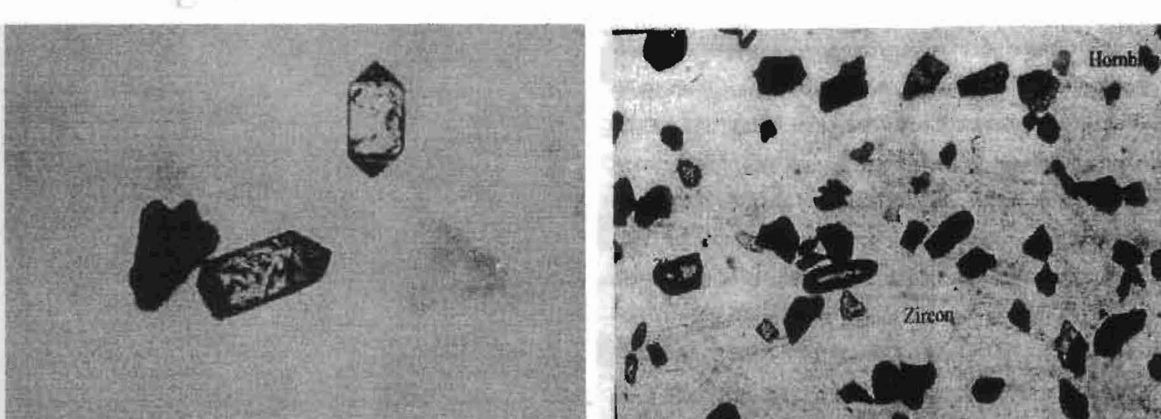
(A) (B)

Fig (3 A and B): Photomicrograph of Pyroxene and Augite mineral grains minerals between crossed-nicols (Profile No. 3).



(A) (B)

Fig (4 A and B): Photomicrograph of Biotite, Zircon and Augite grain minerals between crossed-nicols (Profile No. 6).



(A) (B)

Fig (5 A and B): Photomicrograph of Zircon and Biotite grain minerals between crossed-nicols (Profile No. 6 and 8).

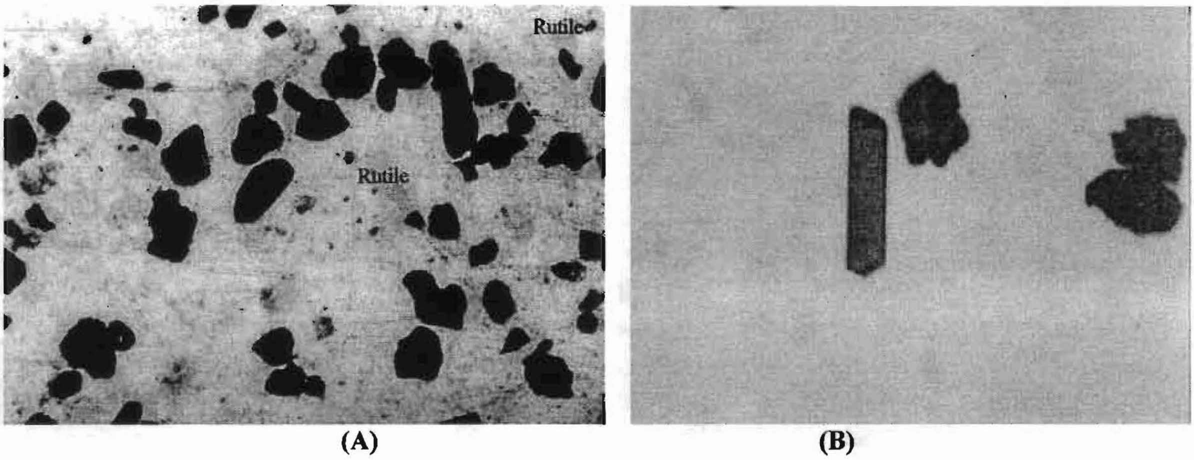


Fig (6 A and B): Photomicrograph of Rutile and other grain minerals between crossed-nicols (Profile No. 5 and 2).

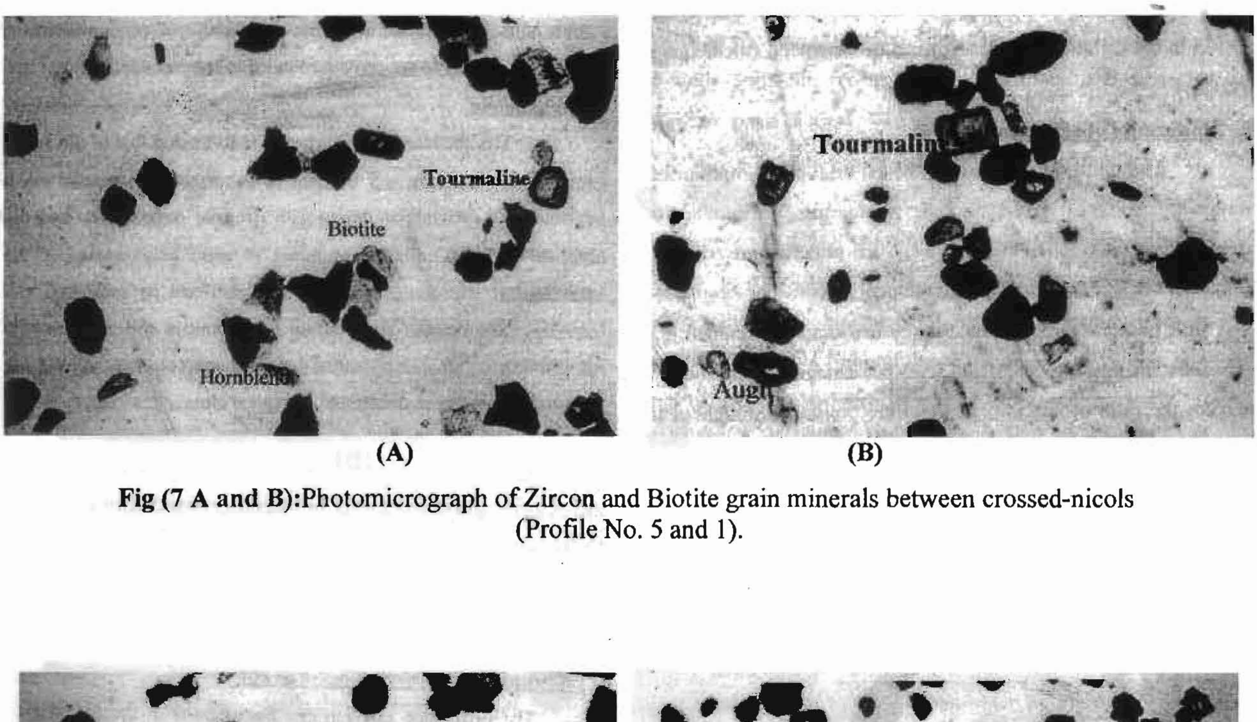


Fig (7 A and B): Photomicrograph of Zircon and Biotite grain minerals between crossed-nicols (Profile No. 5 and 1).

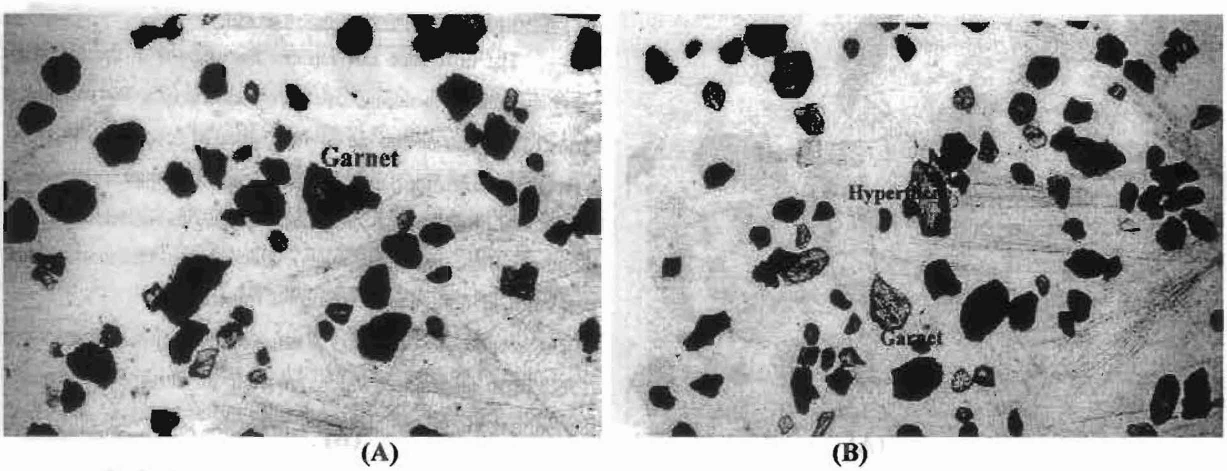
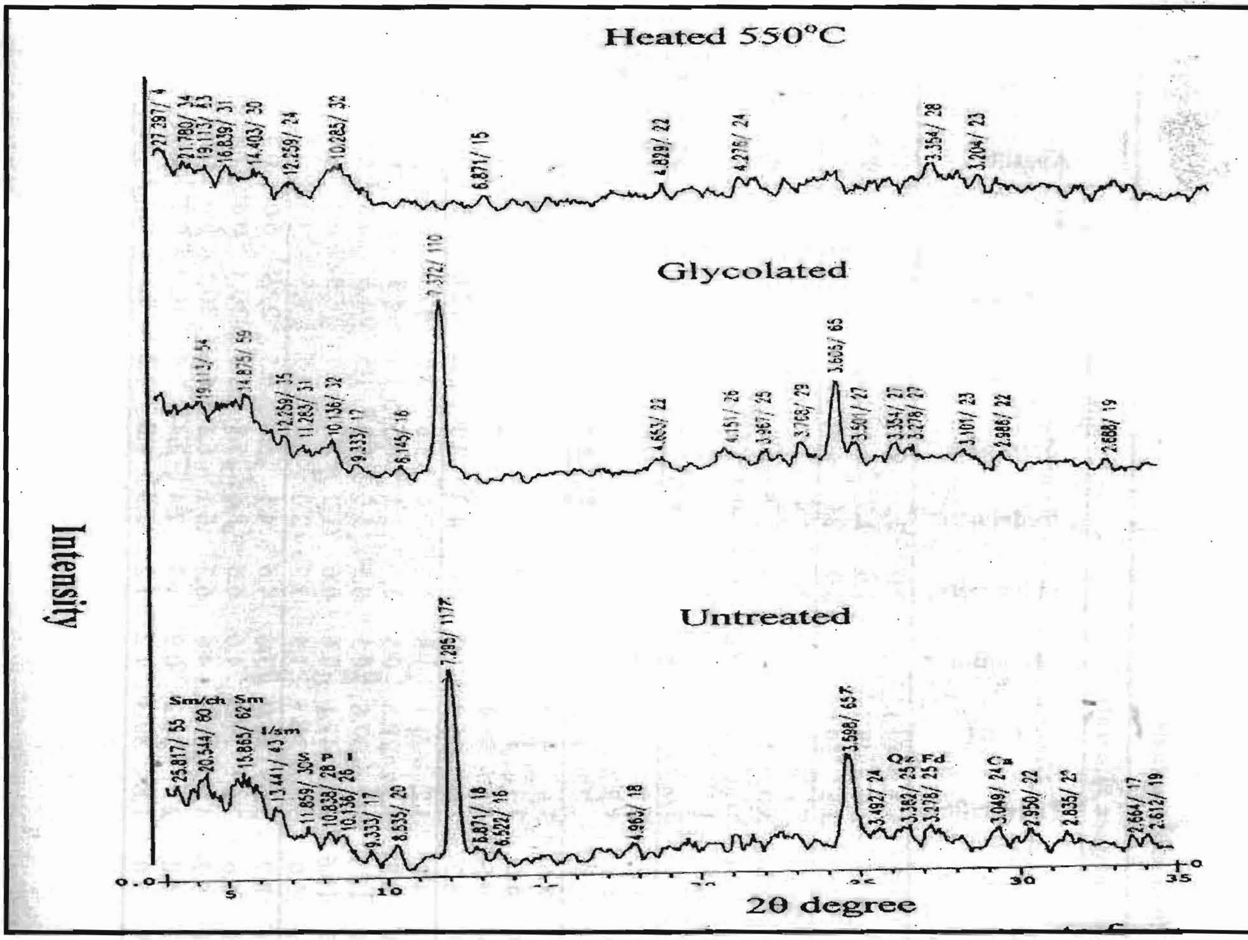
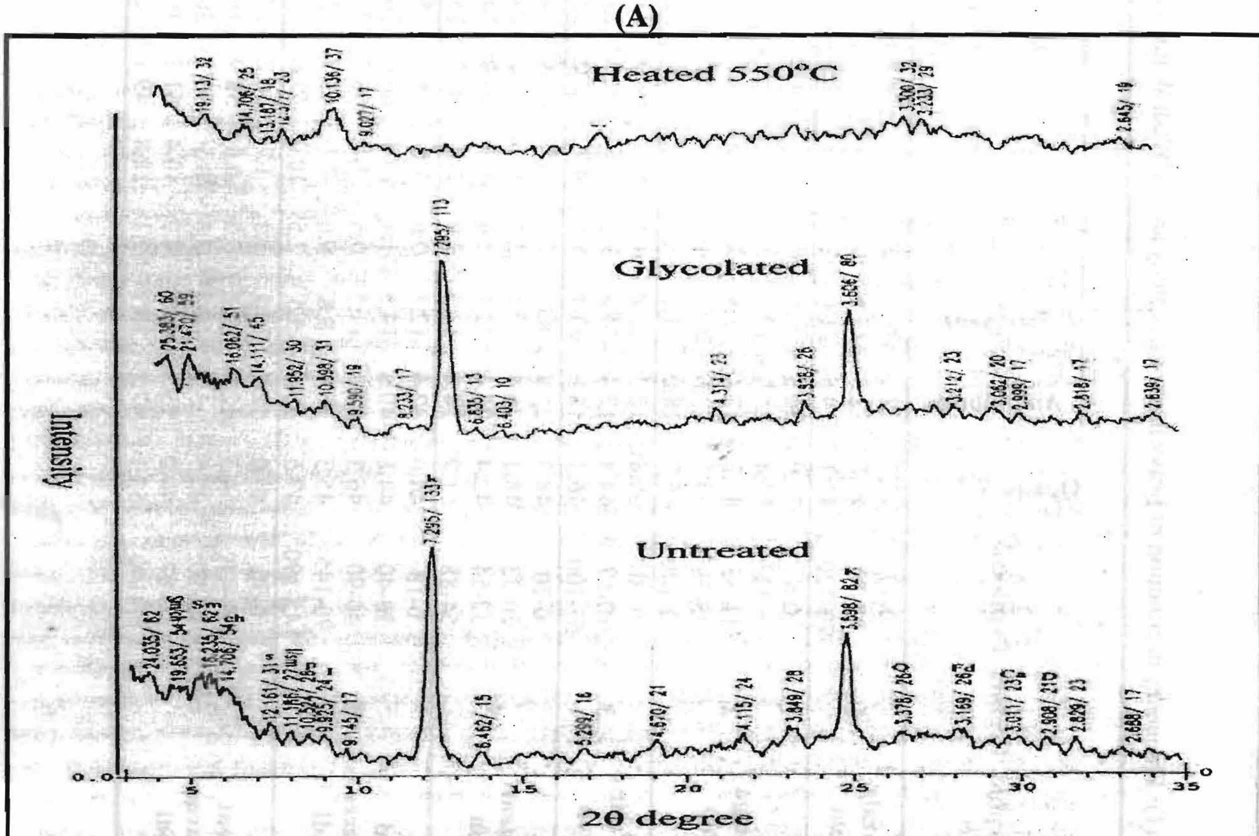


Fig (8 A and B): Photomicrograph Garnet and Hypersthenes grain minerals between crossed-nicols (Profile No. 5 and 1).



(A)



(B)

Fig. (9 A and B) X-ray diffraction pattern of clay fraction separated from different geomorphological units of Wadi Watir soil basin area in the Southeastern of Sinai Peninsula

Table (1): Frequency distribution of heavy minerals in study area of Wadi Watir soils from sand fractions.

Geomorphic Units	Profiles No.	Depth cm	Opaques %	Non Opaques Minerals															Monazite	Apatite	Other
				Amphiboles	Pyroxene	Epidotes	Biotite	Total	Zircon	Rutile	Tourmaline	Total	Kyanite	Sillimanite	Andalusite	Staurolite	Garnet	Total			
WGhazala bottom	1	0-40	43.7	12.5	21.1	3.5	2.5	39.6	30.1	8.7	5.3	44.1	2.0	2.0	2.5	2.5	2.5	11.5	0.0	4.5	0.3
		40-70	40.8	12.3	13.6	0.5	10.1	36.5	29.2	13.3	2.6	45.1	1.6	1.6	3.7	5.2	4.2	16.3	0.7	0.5	0.9
		70-120	41.1	19.5	21.0	2.0	10.0	52.5	24.0	7.5	2.5	34.0	1.0	2.0	2.0	4.0	2.5	11.5	0.5	0.5	1.0
W. Zalaga bottom	2	0-6	53.0	34.3	5.5	0.7	5.5	46.0	35.2	6.3	2.1	43.6	0.7	0.7	1.4	3.5	2.8	9.1	0.0	0.6	0.7
		6-11	50.4	24.0	10.3	3.0	4.0	41.3	33.0	9.0	3.0	45.0	1.8	2.4	3.0	3.0	3.0	13.2	0.0	0.0	0.5
		11-35	49.2	13.4	13.4	2.7	4.8	34.3	37.6	13.4	5.3	56.3	1.0	1.6	1.6	1.6	2.2	7.9	0.0	0.0	1.5
		35-73	44.6	22.6	8.1	4.8	3.6	39.1	31.7	9.3	3.1	43.6	1.5	2.5	3.1	5.2	5.0	17.3	0.0	0.0	0.0
		73-100	46.7	18.0	11.2	1.8	1.8	32.8	30.3	9.0	3.0	42.3	3.0	3.0	5.4	5.4	6.0	22.8	1.0	0.5	0.6
W. Watir bottom	3	0-10	50.8	15.3	25.8	4.8	5.1	51.0	22.9	7.7	2.8	33.4	1.9	3.8	3.7	3.8	3.8	13.2	0.0	1.3	1.1
		10-57	44.8	17.4	24.8	3.2	4.6	50.0	22.6	8.1	4.5	35.2	1.3	2.3	3.2	2.7	3.2	12.7	0.0	1.2	0.9
		57-100	46.1	18.8	23.4	5.1	4.7	52.0	22.1	7.4	2.7	32.2	1.8	2.3	3.7	3.7	3.5	15.0	0.0	0.5	0.3
Pediment Plain	4	0-20	48.0	25.8	8.6	2.3	5.7	42.4	34.5	8.6	3.4	46.5	1.1	1.1	2.8	2.3	2.8	10.1	0.0	0.5	0.5
		20-33	48.1	26.4	13.2	2.0	6.0	47.6	29.8	6.6	3.3	39.7	1.3	1.9	2.6	3.3	3.3	12.4	0.0	0.0	0.3
		33-54	42.4	25.4	12.7	2.6	5.3	46.0	24.4	9.5	4.5	38.4	1.3	2.6	2.6	3.3	3.3	13.1	0.0	1.3	1.2
		54-85	51.9	34.0	12.3	2.0	2.0	50.3	25.7	8.2	2.0	35.9	1.0	2.0	4.0	2.0	3.0	12.0	0.5	0.0	1.3
Old Terraces Wadi	5	0-18	44.0	42.4	12.1	0.6	9.0	64.1	15.1	4.8	1.2	21.1	1.8	1.2	2.4	3.6	3.0	12.0	0.0	1.3	1.5
		18-40	44.8	40.6	14.5	1.1	10.4	66.6	20.3	5.8	1.7	27.8	0.5	1.1	1.1	0.5	1.1	4.3	0.0	0.2	1.1
		40-90	46.3	37.3	11.5	0.5	7.4	56.7	25.8	10.3	1.7	37.8	0.5	0.5	1.0	1.0	1.5	4.5	0.0	0.5	0.5
		90-145	45.3	26.6	8.8	0.6	7.7	43.7	35.5	10.6	3.0	49.1	0.6	0.6	1.2	2.4	1.7	6.5	0.0	0.0	0.7
		145-190	47.5	35.6	5.5	2.5	10.0	53.6	27.6	5.0	3.5	36.1	1.5	1.5	2.0	2.0	2.5	9.5	0.0	0.5	0.3
Recent Terraces Wadi	6	0-30	44.0	12.1	19.1	3.3	1.7	36.2	27.6	8.7	3.6	39.9	3.6	4.6	4.1	5.1	5.5	22.9	0.0	0.4	0.6
		30-45	54.3	12.5	22.5	3.3	0.6	38.9	19.8	6.6	2.6	29.0	4.6	6.6	8.6	5.3	5.3	30.4	0.0	1.3	0.4
		45-70	45.7	13.9	18.3	2.5	0.5	35.2	20.4	9.2	4.0	33.6	4.6	6.2	6.1	6.6	6.6	30.1	0.0	0.0	1.1
		70-87	40.0	23.3	26.7	0.9	10.4	61.3	19.0	4.8	2.4	26.2	0.9	1.9	2.4	2.4	2.4	10.0	0.8	0.9	0.8
		87-140	53.1	47.1	25.1	3.1	18.8	49.1	32.5	5.0	1.8	39.3	1.2	1.2	2.5	1.8	1.8	8.5	0.0	1.5	0.6

Table (1) ***Cont.*:** Frequency distribution of heavy minerals in study area of Wadi Watir soils from sand fractions.

Geomorphic Units	Profiles No.	Depth cm	Opaques %	Non Opaques Minerals																	
				Amphiboles	Pyroxene	Epidotes	Biotite	Total	Zircon	Rutile	Tourmaline	Total	Kyanite	Sillimanite	Andalusite	Staurolite	Garnet	Total	Monazite	Apatite	Other
Recent Terraces Wadi	7	0-33	49.5	17.5	22.7	1.1	2.4	43.7	26.0	8.6	2.9	37.5	1.1	2.9	4.6	4.0	4.6	17.2	0.0	1.1	0.5
		33-70	48.2	20.4	26.1	1.6	3.4	51.5	26.1	5.8	2.3	34.2	1.1	2.3	2.9	1.7	2.9	10.9	0.0	2.3	1.1
		70-110	46.1	21.7	28.0	0.5	3.1	53.3	18.7	7.0	2.6	28.3	1.6	2.6	2.6	4.8	4.8	16.4	0.5	1.0	0.5
		110-150	46.7	15.9	29.7	2.8	2.8	51.2	20.6	7.2	2.5	30.3	1.0	2.0	4.1	5.1	4.6	16.8	0.0	1.0	0.7
Fan Delta	8	0-9	49.8	14.4	15.7	1.4	3.6	35.1	36.0	11.0	3.6	50.6	1.4	2.2	2.2	3.6	2.8	12.2	1.4	0.7	0.0
		9-28	46.1	15.7	15.7	0.7	9.1	41.2	27.4	10.2	4.1	41.7	1.3	2.7	3.4	6.1	3.4	16.9	0.7	2.0	1.3
		28-53	44.2	13.5	21.2	1.3	5.8	41.8	27.4	9.1	3.6	40.7	0.6	0.6	1.2	2.4	2.4	13.3	1.8	1.2	1.2
		53-90	48.7	18.6	20.2	1.8	4.0	44.6	17.6	5.6	2.1	25.3	2.8	7.0	7.0	7.0	5.6	29.4	0.7	0.0	0.0
		90-110	50.7	22.8	8.9	1.0	8.4	41.1	39.6	7.9	3.1	50.6	0.8	1.6	0.8	1.6	0.8	5.6	0.0	1.9	0.8
	9	0-10	46.0	26.6	23.9	2.2	2.2	54.9	22.4	6.2	2.2	30.8	1.3	1.7	2.2	3.1	2.2	1.5	0.0	2.0	0.8
		10-45	46.2	23.6	20.2	1.3	2.2	47.3	24.8	8.6	4.0	37.4	1.3	1.8	3.6	4.0	2.7	13.5	0.0	0.9	0.9
		45-85	45.7	26.7	20.7	1.7	2.2	51.3	21.7	6.6	2.2	31.5	1.7	3.4	4.0	3.4	3.1	15.6	0.0	0.9	0.7
		85-110	45.5	29.3	20.8	1.8	7.8	59.6	17.5	6.6	2.2	26.3	0.9	1.8	3.0	3.9	3.0	12.5	0.0	1.3	0.3
		110-140	43.6	21.5	19.3	2.2	8.2	51.1	19.3	6.4	2.2	27.9	1.7	2.2	4.3	6.0	4.3	18.5	0.0	1.7	0.8

Table (2): Uniformity Ratios for Heavy Minerals in Geomorphic Units of the Studied Soil Profile of Wadi Watir

Geomorphic unit	Profile No.	Depth cm	Index figure	Index minerals	Z/R	Z/T	Z/(R+T)	P+A/Z+R	Weather Index Ratios		
									W_1	W_2	W_3
Wadi Bottom (W. Gazala)	1	0-40	0.07	18.2	2.3	4.6	1.53	3.16	0.95	0.10	0.07
		40-70	0.03	45.1	2.2	11.2	1.84	0.56	0.81	0.02	0.32
		70-100	0.09	34.0	3.2	9.6	2.40	1.19	1.53	0.08	0.38
Wadi Bottom (W. Zalaga)	2	0-6	0.05	50.6	5.6	16.8	4.19	0.67	1.07	0.02	0.15
		6-11	0.03	41.7	3.7	11.0	2.75	0.70	0.95	0.08	0.11
		11-35	0.04	40.1	4.0	10.1	2.88	0.73	0.62	0.06	0.11
		35-73	0.03	25.3	3.4	10.1	2.52	0.74	0.88	0.14	0.10
		73-100	0.04	50.6	3.4	10.1	2.53	0.61	0.88	0.05	0.05
Wadi Bottom (W. Watir)	3	0-10	0.03	56.3	4.0	8.2	2.69	1.40	1.60	0.19	0.20
		10-57	0.01	39.7	2.8	5.0	1.79	1.15	1.56	0.12	0.17
		57-100	0.04	31.4	3.1	8.6	2.29	1.29	1.70	0.21	0.19
Pediment plain	4	0-20	0.05	35.9	2.8	7.1	2.01	0.53	0.91	0.06	0.15
		20-33	0.05	21.1	4.5	9.0	3.01	1.09	1.20	0.06	0.18
		54-85	0.01	27.8	3.9	11.7	2.93	1.02	1.32	0.09	0.18
		85-120	0.01	37.8	3.1	12.9	2.52	1.37	1.67	0.07	0.07
Wadi Terraces (Old)	5	0-18	0.04	49.1	3.1	12.6	2.52	2.74	3.34	0.04	0.55
		18-40	0.06	36.1	3.5	11.9	2.71	2.11	2.50	0.05	0.47
		40-90	0.07	43.6	2.5	15.2	2.15	1.35	1.77	0.02	0.27
		90-145	0.07	45.0	3.3	11.8	2.61	0.77	0.92	0.02	0.20
		145-190	0.07	46.5	5.5	7.9	3.25	1.15	1.32	0.08	0.32
Wadi Terraces (Recent)	6	0-30	0.02	43.6	3.2	7.7	2.24	0.72	1.00	0.11	0.05
		30-45	0.01	42.3	3.0	7.6	2.15	1.08	1.56	0.15	0.03
		45-70	0.03	39.9	2.2	5.1	1.55	0.86	1.32	0.10	0.02
		70-87	0.04	29.0	3.3	6.0	2.15	0.78	2.34	0.04	0.49
		87-140	0.05	33.6	2.5	6.9	1.84	4.09	2.10	0.09	0.55
	7	0-33	0.03	44.1	3.0	9.0	2.26	0.48	1.39	0.04	0.08
		33-70	0.03	19.3	4.5	11.3	3.22	1.24	1.64	0.06	0.12
		70-110	0.04	18.2	2.7	7.2	1.95	1.66	2.33	0.02	0.15
		110-150	0.01	45.1	2.9	8.2	2.12	1.42	1.97	0.12	0.12
Fun Delta	8	0-9	0.02	34.0	3.3	10.0	2.47	0.61	0.76	0.04	0.09
		9-28	0.03	50.6	2.7	6.7	1.92	0.73	1.00	0.02	0.29
		28-53	0.05	41.7	3.0	7.6	2.16	0.73	1.12	0.04	0.19
		53-90	0.06	40.1	3.1	8.4	2.29	1.46	1.97	0.09	0.20
		90-110	0.03	25.3	5.0	12.8	3.60	0.58	0.74	0.02	0.20
	9	0-10	0.04	50.6	3.6	10.2	2.67	1.64	2.05	0.09	0.09
		10-45	0.04	56.3	2.9	6.2	1.97	1.26	1.52	0.05	0.08
		45-85	0.05	39.7	3.3	9.9	2.47	1.61	1.98	0.07	0.09
		85-110	0.04	31.4	2.7	8.0	1.99	1.87	2.54	0.09	0.40
		110-140	0.05	35.9	3.0	9.0	2.26	1.59	1.90	0.10	0.38

Table (3): Clay Mineralogy for some Soil Profiles Samples in Wadi Watir

Geomorphologic unit	Profile No.	Depth, cm	Smectite	Kaolinite	Chlorite	Vermiculite	Illite	Palygorskite	Sepiolite	Mixed layer		Non clay minerals
										Sm-Ch	I -Sm	
Wadi bottom (W. Gazala)	1	0-40	Dom	Mod	Tr.		Tr.	–	--	Tr.	Tr.	Qz, Fd, Ca
		70-120	Abu	Few	Tr.		Tr.	Tr.	Tr.	Tr.	Tr.	Ca, Qz, Fd
Recent Terraces Wadi	3	0-33	Mod	Mod	few	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Ca, Qz, Fd.
		110-150	Few	Few	few	few	Tr.	Tr.	few	few	Tr.	Qz, Fd, Ca
Pediment plain	4	0-20	Mod	Abu	Tr.		Tr.	Tr	Tr.	Tr.	Tr.	Qz, Fd, Ca
		54-85	Mod	Few	mod		Tr.	few	Tr.	Tr.	Tr.	Ca, Qz, Fd.
Old Terraces Wadi	5	145-190	Few	Abu	Tr.		Tr.	Tr.	--	Tr.	--	Qz, Fd.
Delta	9	110-140	Mod	Mod	few		Tr.	Tr.	few	few	Tr.	Ca, Fd, Qz

I = Illite Sm = Smectite Ch = Chlorite Qz= Quartz Fd= Feldspars Ca= Calcite

Abundance (Abu) = > 60%

Dominant (Dom) = 41-60%

Moderate (Mod) =21-40 %

Few = 11-20%

Trace (Tr.) = 3-10%

REFERENCES

Bear, F. E.(1964). "Chemistry of the Soil" (F.E. Bear, ed.) 1: Soil development. Reinhold Publishing Corp., New York.

Brewer, R. (1960). The petrographic approach to the study of soil. Tram-Seventh Int.Cong. Soil Sci., Madison 1, pp. 1-13.

Brewer, R. (1964). "Fabric and Mineral Analysis Soils" John Wiley & Soils, Inc. New York, London.

Jackson, M. L. (1975). Soil chemical analysis-Advanced course. Published by the author. Dept. of soil Scl, Univ. of Wisc., Madsion, USA.

Hammad, M. A. (1968). General of the soil of the western Medetrrarens Coastal. Ph.D. Thesis, Fac. Agric., Ain shams Univ.

Haseman, J. F. and C. E. Marshall (1945). The use of heavy minerals in studies of the origin and development of soils. Mc. Agr. Exp. Sta. Bull. 387.

Humbert, R. P. and C. E. Marshall (1943). Mineralogical and chemical studies of soil formation from acid and basic igneous rocks in Missouri. Mc. Agr. Exp. Sta. Res. Bull. 359, pp. 60

Lotti, G. and V. Averna (1968). The titanium content of soils and clays of Sicily. *Trans* 9th Intern. Cong. Soil Sci., Adelaide A Australia, III, 53.

Milner, H. B. (1962). "Sedimentary Petrography" (Vol. I&II) George Allen and Unwin. Ltd., Museum Street, London.

Polnov, B. P. (1944). Total analyses of soils and their interpretation. Pedology (U.S.S.R.), 10, 482.

السمات المعدنية و علاقتها بنشأه و مدي تجانس أراضي حوض وادي وتير- جنوب شرق سيناء – مصر

فتح الله محمد فرج *- محمد عبد الرحيم عبد العزيز حسن *- خليل إبراهيم خليل **- عبد اللطيف دياب عبد اللطيف **

* قسم الأراضي والمياه- كلية الزراعة- جامعة قناة السويس- ٤١٥٢٢ الاسماعيلية- مصر

** مركز البحوث الزراعية- وزارة الزراعة- الدقى

أختيرت تسعه قطاعات أرضية تمثل الوحدات الأرضية في حوض وادي وتير للتعرف علي المعادن الثقيلة الموجودة في مجموعة الرمل الناعم و كذلك معادن الطين السائدة و علاقتها بنشأه هذه الأراضي و مدي تجانسها.

أوضحت النتائج ان المعادن الثقيلة الموجودة تمثلت في المعادن المعتمة و البيروبولات و الأبيدوت بنسبة مرتفعة بينما الزركون و الروتيل و الترمالين و الشتروليت كانت متواجدة و لكنها بنسبة متوسطة نسبيا. اما المعادن الأخري فتواجدت بنسب أقل. كما تمت دراسة عوامل التجوية من خلال معادلات التجوية المختلفة.

لقد اوضحت الدراسة بأستخدام توزيع المعادن الثقيلة السابقة و علاقتها ببعضها البعض. بأن اراضي الوديان المدروسة هي أما متعددة النشأه لمادة الأصل او تكونت تحت ظروف ترسيب متباينة نتيجة لعدم تجانس مواد الأصل و كذلك نتيجة سيادة التجوية الجيوكيميائية في الرواسب التي تكونت منها. كما أظهرت دراسة القطاعات الأرضية عدم و جود لاي دلائل علي التطور داخل الطبقات السطحية أو التحت سطحية للقطاعات الأرضية المختلفة التي تمثل الوحدات الأرضية و الموفولوجية لمنطقة الدراسة.

كما اوضحت الدراسة التركيب المعدني لمعادن الطين بواسطة أشعة أكس لمحتوي تلك الأراضي من تلك المعادن وتبين انها تحتوي علي مجموعة من المعادن المتمددة (السمياكتيت) و الكاؤولنيت و الأليت و البلاجروسكيت بنسب متفاوتة و قد تم مناقشة هذا التباين في أنواع معادن الطين الذي قد يرجع الي اصل و منشأ تلك الأراضي من مواد اصل مختلفة (مواد اصل نارية و متحولة و في بعض الأحيان رسوبية).