

ALTERATION OF SOME ALLUVIAL SOILS IRRIGATED WITH DIFFERENT WATER RESOURCES, ASSIUT, EGYPT.

M. A. Faragallah¹ & M. A. Essa²

1- Soil and Water Sci. Dep., Fac. Agric., Al Azhar Univ. Assiut, Egypt.

2- Dept. of Geology, Fac. of Sci., Assiut University, Egypt.

Abstract: The present work represents the study of the origin, uniformity, weathering as well as any mineralogical changes that occur in the fine and very fine sand fractions of some Nile alluvial soils irrigated with different water sources. Four localities were chosen to represent soils irrigated with Nile, artesian, incompletely sewage-polluted Nile and agricultural drainage-polluted Nile waters.

Fine and very fine sand fractions were separated into heavy and light minerals. The levels of heavy minerals within studied sand fractions are relatively low (0.46 – 8.75 %) in all studied soil samples. Heavy minerals include opaque and non-opaque minerals. Opaque minerals are the less abundant in all examined soils samples, without any specific trend with depth. The non-opaque minerals are present in the following manner: pyroxenes (including augite, diopside, hypersthene and enstatite) are in pronounced amounts, followed by amphiboles (including hornblende, chloritized hornblende and tremolite) and epidotes in most sites. Spene, biotite, zircon and garnet are recorded in relatively moderate amounts, whereas, rutile, Tourmaline and staurolite are found as traces. Only one apatite value (0.51%) is detected in the soil surface irrigated with artesian water. The light minerals are the most dominant in the examined fine

and very fine sand fractions with contents up to 99.54%. Quartz is the most abundant mineral in all studied soil samples, whereas, feldspars are found in small amounts followed by calcite. These mineral assemblages indicate that soil materials have originated from igneous, metamorphic and sedimentary rocks. Regarding soil uniformity and weathering, these soils are stratified and are of multi-origin and/or formed under multi-depositional regimes, and are weakly affected by weathering.

Respecting alteration of some minerals, slight alteration of hornblende to chlorite at the grain peripheries, and slight to moderate feldspar alteration to sericite have been noticed in various studied soils. Plagioclases represent the main altered feldspars in all studied soils followed by orthoclase and microcline. These alterations may be mainly due to processes of geochemical weathering in the source minerals of these soils.

Concerning correlation coefficients between DTPA-extractable metals, i.e. Fe, Mn, Zn, Cu, Pb, Ni as well as B and its bearing-minerals in soils, there are insignificant relations and almost negative in most cases, indicating that these minerals do not express the main sources of these elements in the studied soils. Instead, these considerable extractable

elements could be ascribed, in part, to other sources; mainly irrigation water and

applications of different fertilizers during agricultural practices in these soils.

Key words: Sand mineralogy, alteration, sewage, agricultural drainage, artesian water.

Introduction

Minerals occur in soils as a result of (i) inheritance from parent materials, (ii) authigenic formation by crystallization from solution, or (iii) alteration of existing minerals into new species (Allen and Hajek, 1989 & Tucker, 2001).

In general, it is recognized that the weathering of a mineral is affected by its composition, coefficients of expansion, cleavage and original defects in the crystals, hardness and specific surface. Additional external factors are the physical, biological and chemical (oxidation/reduction, hydration, hydrolysis, pH, chelation, cation exchange, carbonation) conditions of the weathering environment (Rai and Kittrick, 1989). Mineral weathering releases plant nutrients that are retained by other minerals through adsorption and precipitation. Minerals are indicators of the amount of weathering that has taken place, and the presence or absence of particular minerals gives clues as to how soil is formed (Schultz, 1989).

The efficiency of prevailing weathering process could be measured by the ratios between the most susceptible weathered minerals

and the ultra stable ones (Hammad, 1968). Evaluations of profile uniformity and weathering of some Nile alluvial soils were done by several authors (Labib and Hamdi, 1972; Elwan *et al.*, 1980; Gewaifel *et al.*, 1981; Noaman, 1989; Lotefy, 1997; Farragallah and Essa, 2004).

This work aims to study the mineralogical composition of sand fraction, consequently soil origin and uniformity. Also, to detect the effect of irrigation by fresh and polluted Nile water (sewage and agricultural drainage), as well as ground water, for long terms, on weathering and alteration of soil minerals of Nile alluvial sediments.

Materials and Methods

Four soil profiles were selected to represent the Nile alluvial soils irrigated with different water sources for long terms, at Assiut city (Fig.1). The first profile represents soils irrigated with natural Nile water. The second profile represents soils irrigated with artesian water. The third and fourth profiles were chosen to represent the soils irrigated with polluted Nile water, i.e. incompletely treated sewage water and agricultural drainage water, respectively. Soil profiles were dug deep to 150 cm and

morphologically described (Table 1) according to Soil Survey Staff (1999). Soil samples were collected according to the vertical morphological variations. Also irrigation water samples were collected from each water source used and chemically analyzed (Table 2). The physical and chemical analyses of both soil and water samples (Table 3) were performed according to page (1982) and Klute (1986). Some elements such as Fe, Zn, Mn, Cu, Ni, B and Pb were extracted and determined (Table 4) according to Lindsay and Norvell (1978).

Fine and very fine sand fractions (0.25-0.063 mm) were used for mineralogical analyses. Separations of the heavy and light minerals were carried out using the procedure of Brewer (1964) Identification of these minerals has done according to Milner (1962) and Mange & Maurer (1992). The ratios between some ultra stable minerals were used to evaluate the uniformity ,while the ratios between less stable and ultra stable minerals were used to evaluate the weathering values according to Haseman and Marshall (1945), Barshad (1964), Brewer (1964), Chapman and Horn (1968) and Hammad (1968).

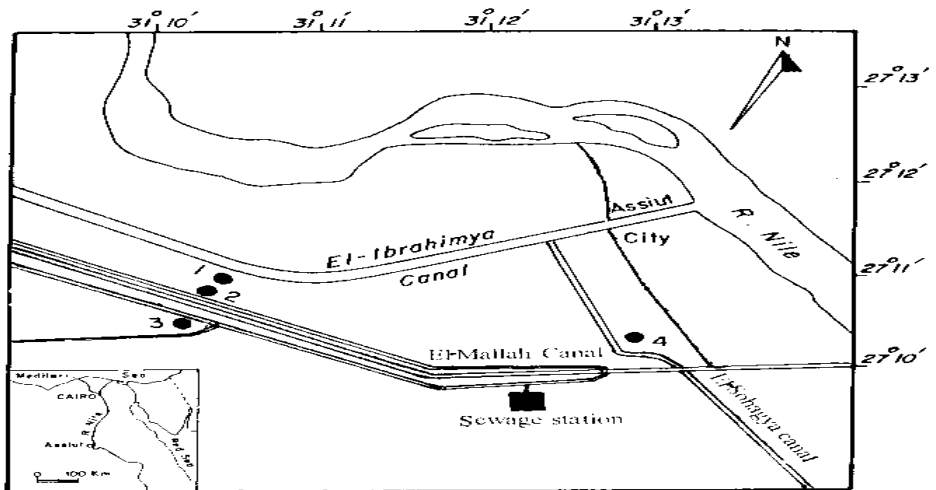


Fig.(1) Location of the studied soil profiles

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

Profile No.	Drainage	Grown Crop	Horizon		Colour			Texture grade	Structure	Consistency			Boundary
			Depth Cm	Symbol	Hue	Dry	Moist			Dry	Moist	Wet	
1	well drained	Clover	0 - 15	Ap	10 YR	4/3	2/2	sandy loam	mo f to m sbk	sh	fr	s	cs
			15 - 45	C1	10 YR	4/4	3/3	sandy loam	mo f to m sbk	sh	fr	ss	as
			45 - 150	C2	10 YR	5/2	3/2	sand	structureless	l	l	so	
2	Moderately well drained	Garlic	0 - 25	Ap	10 YR	5/3	3/3	sandy loam	mo f to m sbk	sh	fr	s	cs
			25 - 65	C1	10 YR	6/3	3/3	sandy loam	mo f to m sbk	sh	fr	s	as
			65 - 150	C2	10 YR	5/3	3/3	loam	s f to c sbk	h	fi	vs	
3	well drained	Wheat	0 - 10	Ap	10 YR	4/2	3/2	sandy loam	w vf to m sbk	s	fr	ss	cs
			10 - 30	C1	10 YR	6/3	3/3	sandy loam	mo f to m sbk	s	fr	s	aw
			30 - 150	C2	10 YR	4/3	2/2	sandy loam	w f to m sbk	s	fr	ss	
4	Moderately well drained	Wheat	0 - 25	Ap	10 YR	4/3	3/2	loam	mo f to c sbk	h	fi	vs	cs
			25 - 45	C1	10 YR	4/4	2/2	loam	s f to c sbk	vh	fi	vs	as
			45 - 150	C2	10 YR	5/3	3/3	clay loam	s f to c sbk	vh	vfi	vs	

Structure: w = weak, mo = moderately, s = strong, vf = very fine, f = fine, m = medium, c = coarse, g = granular, sbk = subangular blocky.

Consistency: Dry: sh = slightly hard, l = loose, s = soft, h = hard, vh = very hard. Moist: fr = friable, fi = firm, vfi = very firm,

Wet: so = nonsticky, ss = slightly sticky, s = sticky, vs = very sticky

Boundary: as = abrupt smooth, aw = abrupt wavy, cs = clear smooth .

Table (2): Some chemical properties of the irrigation waters used.

Character	Fresh Nile	Artesian	Sewage polluted Nile	Agric. drainage polluted Nile
pH	7.28	7.37	7.40	8.20
EC(ds/m)	0.40	1.09	0.96	0.77
SAR	1.79	1.66	3.51	2.66
Cations(meq/l):				
Ca ⁺²	0.80	1.00	1.20	0.80
Mg ⁺²	0.80	3.00	1.20	2.00
Na ⁺	1.60	2.35	3.85	3.15
K ⁺	0.20	0.40	0.65	0.20
Anions(meq/l):				
CO ₃ ⁻⁻	0.40	0.80	0.20	0.40
HCO ₃ ⁻	2.40	6.20	4.80	3.80
Cl ⁻	0.60	2.00	1.80	2.20
SO ₄ ⁻⁻	0.40	1.50	2.20	1.20
Heavy metals (ppm)				
Fe	0.14	0.28	0.35	0.16
Mn	0.08	0.12	0.24	0.10
Zn	0.08	0.10	0.18	0.08
Cu	0.02	0.04	0.16	0.04
Ni	0.03	0.03	0.10	0.03
Pb	0.13	0.09	0.25	0.14
B	0.09	0.10	0.14	0.09

Table (4): Concentrations (ppm) of metals in the studied soil samples.

Profile No.	Depth(Cm)	Fe	Mn	Zn	Cu	Ni	Pb	B
1	0 – 15	13.71	9.68	1.65	3.08	0.43	0.39	0.66
	15 – 45	14.89	7.56	0.52	1.79	0.26	0.28	0.57
	45 – 150	10.21	5.22	0.31	0.54	0.22	0.36	0.45
2	0 – 25	15.25	18.97	1.16	2.44	0.64	0.43	1.16
	25-65	15.62	6.44	0.50	1.75	0.35	0.39	1.07
	65-150	15.65	16.50	0.91	2.69	0.60	0.29	1.13
3	0-10	8.17	13.73	1.63	3.63	0.48	0.49	0.70
	10 30	12.41	24.90	1.62	2.55	0.50	0.24	0.80
	30-150	14.24	4.84	0.52	1.06	0.28	0.36	0.44
4	0-25	7.67	5.58	0.58	2.49	0.49	0.06	0.57
	25-45	11.40	22.83	0.63	2.61	0.32	0.16	0.49
	45-150	4.24	28.18	0.53	3.24	0.48	0.25	0.58

Results and Discussions

Mineralogical composition of the sand fraction:

Data in Table 5 show that fine and very fine sand fractions (0.25-0.063 mm) represent the main constituent within the total sand fractions of the studied soils irrigated with fresh Nile water (up to 91.7%). They are represent moderate percentage of sand fractions of soil irrigated with artesian and sewage polluted Nile water.

While the soil irrigated with agricultural drainage- polluted Nile water have little amounts of these fractions. The first three profiles that are in the same neighborhood have the same distribution trend of fine and very fine sand fractions within total sand fractions. This reflects the similarity of sedimentation regimes in these soils. Fine and very fine sand fractions were separated into heavy and light minerals (Table 5).

Table(5): Relative abundant of heavy and light fractions in fine and very fine sand fractions (0.25- 0.063mm.).

Profile No.	Depth (Cm)	Fine & v. fine		Heavy frac.		Light frac.		Index figures %
		Weight	% in T.sand	Weight	%	Weight	%	
1	0-15	20.39	57.61	1.26	6.18	19.13	93.82	6.59
	15-45	14.21	40.66	0.85	5.98	13.36	94.02	6.36
	45-150	41.58	91.7	3.64	8.75	37.94	91.25	9.59
2	0-25	10.38	35.05	0.25	2.41	10.13	97.59	2.47
	25-65	10.96	32.31	0.07	0.64	10.89	99.36	0.64
	65-150	5.78	42.24	0.11	1.9	5.67	98.1	1.94
3	0-10	12.36	36.53	0.26	2.1	12.1	97.9	2.15
	10 30	8.62	29.05	0.34	3.94	8.28	96.06	4.11
	30-150	15.59	39.28	0.27	1.73	15.32	98.27	1.76
4	0-25	4.34	19.65	0.02	0.46	4.32	99.54	0.46
	25-45	4.37	20.36	0.05	1.1	4.32	98.9	1.16
	45-150	1.18	8.31	0.03	2.54	1.15	97.46	2.61

a. Heavy Minerals:

Levels of heavy minerals within the studied sand fractions and their index figures are relatively low in all studied soil samples; as they range between 0.46 to 8.75 % and from 0.46 to 9.59 %, respectively (Table 5). The first and second profiles have the same trend of heavy minerals distribution with depth. While profiles 3-5 show another trend. This could be attributed to the position away from the Nile stream.

Heavy minerals include opaque and non-opaque minerals. Opaque minerals are the less abundant in all examined soils samples with ranges from 28.57 to 45.45% of the heavy fraction for the first three soils, and from 19.26 to 34.82% in the fourth profile (Table 6). There is no clear trend for opaque minerals distribution throughout various profiles. The non-opaque minerals are the most abundant in all studied soil samples. They are presented in the following manner: pyroxenes (including augite, diopside, hypersthene and enstatite) are in pronounced amounts, followed by amphiboles (including hornblende, chloritized hornblende, tremolite and actinolite) and epidotes in the first three sites. However, amphiboles, pyroxenes and biotite are found in pronounced amounts followed by epidotes in the soil of profile 4. Sphene, biotite, zircon and garnet are recorded in relatively moderate amounts, whereas rutile is found as traces. Tourmaline is found in some

samples (the surface of profile 4, the lower layer of profile 2 and all layers of profile 3), but staurolite is recorded in all layers of profile 2. Only one apatite value (0.51%) is detected in the soil surface irrigated with artesian water, and could probably be added from artesian waters that carried it during movement through underground bearing rocks.

The appearance of pyroxenes, particularly augite, in abundant quantities, shows that these sediments are mainly related to Abyssinian plateau, which is rich in augite of volcanic province (Shukri, 1951).

From the heavy minerals types and characteristics, especially, less stable minerals i.e. pyroxenes, amphiboles, epidotes and biotite that are present in high amounts, it is evident that these soils are relatively young and weakly developed (Morton and Hallsworth, 1999).

b. Light Minerals:

Data in Table 5 clearly indicate that light minerals are the most dominant fraction in the studied fine and very fine sand with contents up to 99.54%. Quartz represents the major mineral in examined sand fractions of all studied soil samples with the range of 84.35% to 91.27%, without any specific trend of distribution throughout the studied profiles (Table 7). Feldspars are found in small amounts (6.35% - 12.67%) in the studied localities. Calcite is present in much lower amounts, (from 0.67% to

5.26%), the lowest values belong to soils irrigated with natural Nile and agricultural drainage-polluted Nile waters, while the highest values are recorded in soils irrigated with artesian and sewage-polluted Nile waters, reflecting the effect of these irrigation water types (Table 2).

Table (7): Frequency distribution of minerals in the light fraction.

Profile No.	Depth (Cm)	Quartz %	Feldspars		Total	Calcite %
			Fresh	Altered		
1	0-15	86.67	5.33	7.33	12.67	0.67
	15-45	91.27	4.56	3.38	7.94	0.79
	45-150	86.49	3.38	8.78	12.16	1.35
2	0-25	91.27	1.59	4.76	6.35	2.38
	25-65	84.35	6.09	5.22	11.30	4.35
	65-150	88.79	4.67	4.67	9.35	1.87
3	0-10	89.51	1.85	4.32	6.17	4.32
	10-30	88.71	2.42	5.65	8.06	3.23
	30-150	82.24	5.26	7.24	12.50	5.26
4	0-25	90.24	2.44	5.69	8.13	1.63
	25-45	87.84	1.35	9.46	10.81	1.35
	45-150	89.74	2.56	6.41	8.97	1.28

Pyroxenes are mainly derived from basic and ultra-basic igneous rocks and its equivalent volcanic ones. Amphiboles, biotite and garnet are derived from igneous and metamorphic rocks. Epidotes, sphene and staurolite mainly originate from the weathering of metamorphic rocks. Zircon and tourmaline result essentially from the decomposition of acid igneous rocks and schists. Rutile is formed from the weathering of acid igneous rocks, crystalline metamorphic rocks and decomposition of ilmenite. Apatite is present as euhedral prismatic colourless crystal,

indicating that it was derived from igneous rocks (granites and syanites). Quartz and feldspars are derived mainly from acidic igneous rocks and metamorphic rocks. Whereas, calcite is mainly found due to the weathering of sedimentary rocks especially limestones or due to the precipitation from solutions (Milner, 1964). Accordingly, the previously types and percentages of mentioned assemblages of heavy and light minerals indicate that these soils are formed from multi-origin.

Furthermore, wind activities should not be neglected, where it

transports the finer sediments resulting from the weathering of varieties of sedimentary rocks of the Western desert plateau and their addition to soil surface.

These obtained findings indicate that soil materials have originated from igneous and metamorphic rocks, probably related to Ethiopian plateau (Said, 1981) and/or Abyssinian plateau, basaltic-Sudan and granitic Aswan (Labib, 1970) and Khater and Mansour (1985). Addition of aeolian fine sediments from desert plateaus can not be neglected.

2- Soil uniformity and weathering:

The ratios of highly resistant minerals, suggested by Haseman and Marshall (1945), Barshad (1964), Brewer (1964) and Chapman and Horn (1968), for each profile to elucidate the homogeneity or heterogeneity of the parent materials were applied. Data in Table (8) reveal variations among sites and also throughout profile layers. This assures that these soils are stratified and are of multi-origin and/or formed under multi-depositional regimes and apparently cause the heterogeneity of soil material.

Table (8): Uniformity and weathering ratios of the studied profiles.

Profile No.	Depth (Cm)	Uniformity ratios			Weathering ratios		
		Zr/R	Zr/T	Zr/R+T	A+P/Zr+T	H/Zr+T	B/Zr+T
1	0-15	3.46	3.46	3.46	12.50	0.88	0.63
	15-45	1.99	1.91	1.99	22.50	2.50	1.50
	45-150	4.98	2.69	4.98	18.00	2.40	1.60
2	0-25	5.98	3.05	5.98	11.97	0.67	1.34
	25-65	1.02	1.02	1.02	46.97	3.50	9.56
	65-150	11.06	11.06	5.53	4.92	0.33	0.33
3	0-10	3.80	9.50	2.71	2.05	0.21	0.02
	10 30	4.25	2.43	1.55	4.13	0.25	0.13
	30-150	4.29	15.09	3.33	2.72	0.34	0.22
4	0-25	2.50	5.00	1.67	20.02	2.33	9.01
	25-45	1.00	0.63	1.00	21.25	2.25	31.75
	45-150	5.05	2.02	5.05	19.40	1.60	5.40

- Zr: zircon, R: rutile, T: tourmaline, A: amphiboles, P: pyroxenes, H: hornblende, B: biotite.

With respect to the weathering ratios, calculated between less stable and ultra stable minerals (amphiboles + pyroxenes, hornblende and biotite divided by zircon + tourmaline), data

in Table (8) show that the obtained values are high. This reflects the weak effect of weathering processes on these soils under the prevailing arid climate and/or confirms their

relatively high content of less stable minerals of pyroxenes, amphiboles and biotite. These data also show that weathering ratios in soil surfaces are lower than subsurface layers. This may indicate that the surface soil layers have been subjected to relatively higher weathering processes than lower ones. The variations in weathering ratios among profiles and also between layers in each profile emphasize that these soils are formed from multi-origin and/or due to multi-sedimentation modes. These results are in agreement with those obtained by Noaman (1989), Amira et al. (2000) and Faragallah and Essa (2004).

3- Alteration of some minerals:

The less stable minerals such as hornblende in heavy fraction and feldspar in light one show some

alteration to another minerals (Tables 6 & 7).

Concerning alteration of hornblende, Stephen (1952) stated that hornblende initially alters to chlorite with some sphene, hematite and epidote. In the studied localities, slightly alteration of hornblende to chlorite at the grain peripheries was observed (Fig. 2).

Data in Table 9 indicate that alteration percentages range between 40 and 85.96. The smallest value are found in the lower layers of soils irrigated with fresh Nile, artesian and sewage polluted Nile Water while the highest value is recorded in the lower layer of soil irrigated with agricultural drainage polluted Nile water. No clear trend of chloritized hornblende with depth in different sites was detected (Fig. 3).

Table(9): Alteration percentages of hornblende and feldspars in the examined soil samples.

Profile No.	Depth (Cm)	Hornblende		Alt.%	Feldspars		Alt.%
		Fresh	Alt.Chlor		Fresh	Alt.Seri.	
1	0-15	3.03	5.63	65.01	5.33	7.33	57.85
	15-45	4.78	6.22	56.55	4.56	3.38	42.57
	45-150	6.45	4.30	40.00	3.38	8.78	72.20
2	0-25	2.03	4.06	66.67	1.59	4.76	74.96
	25-65	3.57	8.16	69.57	6.09	5.22	46.19
	65-150	2.45	1.84	42.86	4.67	4.67	49.95
3	0-10	2.56	4.55	63.99	1.85	4.32	70.02
	10 30	2.03	4.73	69.77	2.42	5.65	70.10
	30-150	4.15	3.40	45.03	5.26	7.24	57.92
4	0-25	5.19	16.67	76.26	2.44	5.69	69.99
	25-45	3.17	6.98	68.77	1.35	9.46	87.51
	45-150	3.24	19.84	85.96	2.56	6.41	71.46

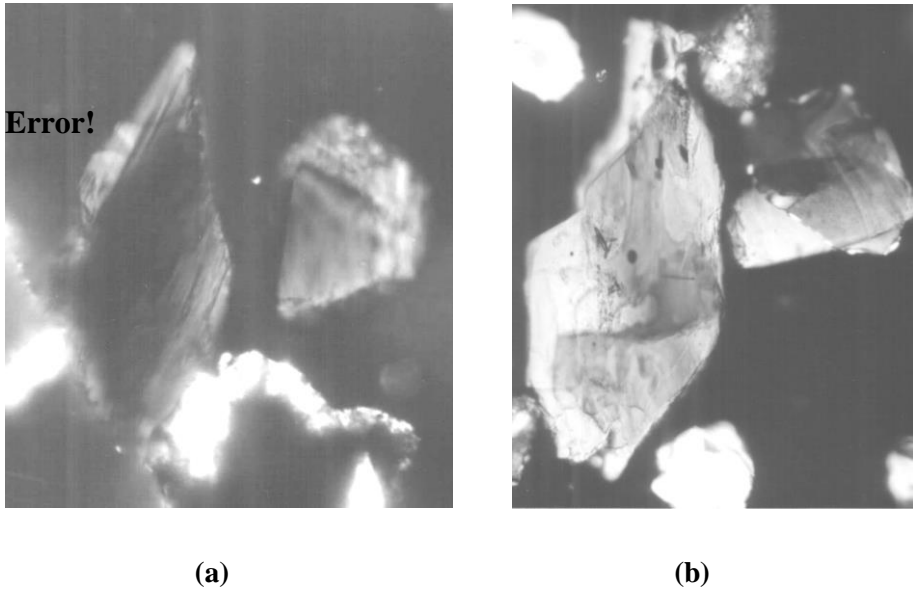


Fig (2): Grains of hornblende in the studied soils, (a): fresh and (b): slightly altered.

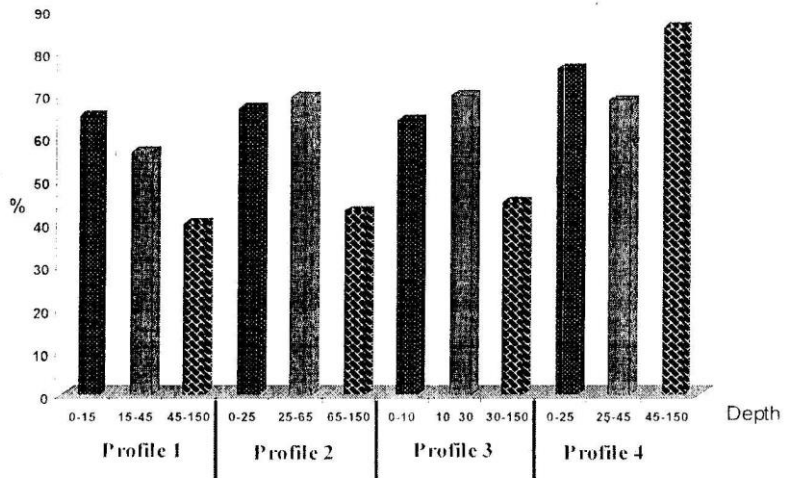


Fig. 3: Distribution of the altered hornblende at different depths in the studied profiles.

It has been stated by many authors that kaolinite, sericite, montmorillonite, gibbsite, halloysite and amorphous aluminosilicate minerals may form from feldspars in the different weathering zones (Bates, 1962; Keller et al., 1971; Eswaran and Wong, 1978; Calvert et al., 1980; Harris et al. 1982; Vazquez, 1981; Adams et al., 1984 and Tucker, 2001). Alteration of feldspars to secondary minerals is a function of the microenvironment (Eswaran and Wong, 1978 & Milliken, 1989).

Slightly to moderately feldspar alterations to sericite are noticed in various studied soils (Fig. 4). The range of altered feldspar varies from 42.57 to 87.51%, without any specific pattern throughout soil profiles (Table 9 and Fig. 5). The lowest percentages are obtained in the subsurface layers of soils irrigated with fresh Nile and artesian waters, whereas the highest one belongs to the soil subsurface irrigated with agricultural drainage polluted Nile water.

In this respect the altered plagioclase represents the main altered feldspars in all studied samples, followed by orthoclase and microcline. This is in agreement with the stability degree of feldspars; since potassic feldspars are generally considered to be more resistant to weathering than the plagioclases (Allen and Hajek, 1989 & Tucker, 2001).

Dealing with the alteration ratios of hornblende and feldspars in the studied sites (Table 9), it is clear that these ratios are slightly different among various profiles, but they are widely variant between one layer to another within each profile. Based on these discussions, it could be stated that these alterations may be mainly due to the processes of geochemical weathering in the source area of these minerals. However, the effect of pedochemical weathering processes by long-term irrigation water is not so evident.

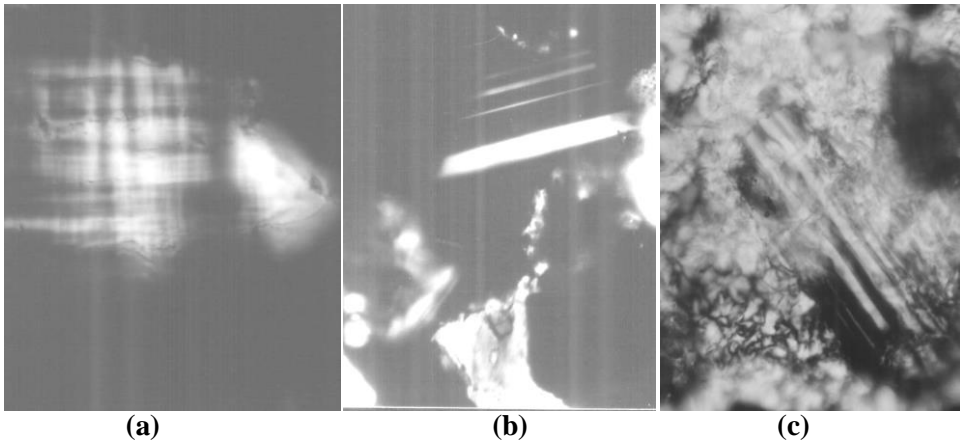


Fig (4): Grains of feldspars in the studied soils, (a): fresh microcline, (b): fresh plagioclase and (c): moderately altered plagioclase.

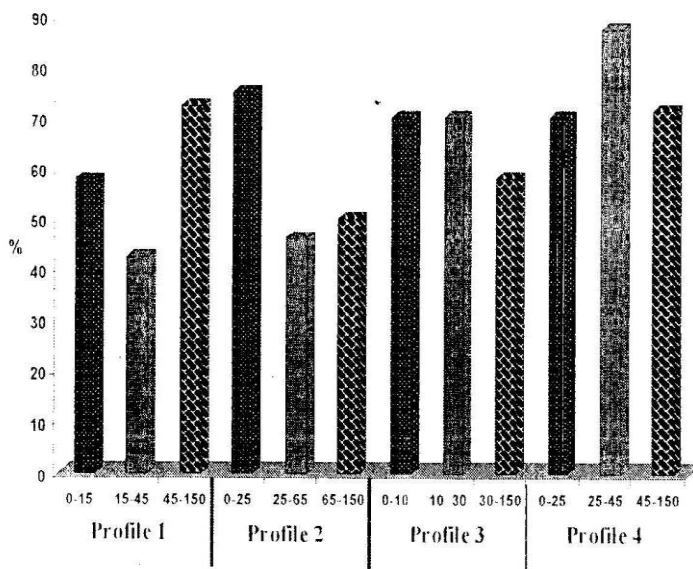


Fig. 3: Distribution of the altered feldspars at different depths in the studied profiles.

4- Relationship between mineralogical composition and extractable elements:

The possibility to relate trace element contents of a soil to their mineralogical composition or not depends actually on the intensity of weathering processes prevailing in the course of soil formation (Sillanpaa, 1962 and Mitchell, 1964). Each or more of these trace elements such as Fe, Mn, Zn, Cu, Pb, Ni and B are constituents of one or more of the following minerals: opaques, epidotes, amphiboles, pyroxenes, biotite, garnet, rutile, sphene, quartz and feldspars (White, 1957; Wiklander, 1958; Gladilovich and Sergeeva, 1971; Wedepohl,

1974; Ribbe, 1975 and Dress and Wilding, 1978).

Based on these information, correlation coefficients were calculated between DTPA-extractable elements and its bearing-minerals in soils (Tables 4, 10 and 11). Values obtained are insignificant and almost are negative in most cases (Table 10), indicating that these minerals could not be considered the main sources for the extractable elements in the studied soils. This may be attributed to either the weak effect of weathering processes and/or to the relatively very low levels of these minerals in

the studied soils (Table 10), and subsequently the release of these elements from its bearing-minerals is very low. However, the considered contents of these extractable elements obtained could be ascribed to their content in

irrigation water (Table 2) and also to applications of different fertilizers during agricultural practices. Most of these results coincide with those reported by Mohamed (1982), Faragallah (1995) and Faragallah and Essa (2004).

Table(11): Correlation coefficients between extractable elements and its bearing minerals.

Element	Mineral in soil%	r	Element	Mineral in soil%	r
Fe	Opaques	0.009	Cu	hornblende	-0.634
	Epidotes	-0.661		augite	-0.517
	Amphiboles	-0.044		biotite	-0.636
	Pyroxenes	-0.025		garnet	-0.484
	Biotite	-0.070		rutile	-0.642
	Feldspars	0.141		sphene	-0.620
Mn	Opaques	-0.413		feldspars	-0.678
	Epidotes	0.530		Pb	opaques
	Hornblende	-0.389	amphiboles		0.203
	Garnet	-0.303	biotite		0.133
	Rutile	-0.399	quartz		-0.247
	Sphene	-0.342	feldspars		0.362
Zn	Opaques	-0.139	Ni		hornblende
	Hornblende	-0.310		pyroxenes	-0.510
	Pyroxenes	-0.217		biotite	-0.547
	Biotite	-0.348		garnet	-0.434
Cu	Opaque	-0.547	B	tourmaline	0.044
	Epidotes	0.303			

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التغير في بعض الترب الرسوبية والتي تروى بمصادر مياه مختلفة ، أسيوط ، مصر.

محمد الأمين عبد الكريم فرج الله¹ ، محمود أحمد عيسى²
قسم علوم الأراضى والمياه - كلية الزراعة- جامعة الأزهر فرع أسيوط
قسم الجيولوجيا - كلية العلوم - جامعة أسيوط.

تم اختيار أربعة قطاعات أرضية تمثل بعض الأراضى الرسوبية بمدينة أسيوط ، والتي تروى بمصادر مياه مختلفة هي : مياه النيل الطبيعية والمياه الجوفية و مياه النيل الملوثة بمياه الصرف الصحى والملوثة بالصرف الزراعى ، وذلك لدراسة التركيب المعدنى لحبيبات الرمل الناعم (0.25- 0.063 مم) ومدى تجويتها و تحولها و انحلال بعض العناصر منها.

وقد أوضحت النتائج المتحصل عليها أن كمية المعادن الثقيلة فى الرمل الناعم كانت قليلة (0.46- 8.75%) و يسود فيها المعادن الغير معتمة و تشمل : البيروكسينات (الأوجيت - الديوبسيت - الهيرثين - الانستاتيت) و الأمفيبولات (الهورنبلند الطبيعى والمتحول - التريموليت) و الابدوت و هذه المعادن موجودة بكميات كبيرة. ثم السفين و البيوتيت و الزركون و الجارنت فموجودة بكميات متوسطة. بينما الروتيل و التورمالين و الستورولايت موجودة بكميات قليلة. و قد ساد معدن الكوارتز فى المعادن الخفيفة، مع كمية قليلة من الفلسبار ، بالإضافة الى معدن الكالسيت.

وقد دلت الدراسات التى أجريت على هذه المعادن أن أراضى هذه الترب ذات مواد أصل متعددة أو أنها تعرضت لظروف ترسيب متنوعة، و أن هذه الأراضى ضعيفة التجوية و التطور.

كما أظهر الفحص الميكروسكوبى للمعادن وجود تحول طفيف لبعض حبيبات معدن الهورنبلند الى الكلوريت فى حواف الحبيبات، مع وجود تحول يتراوح من طفيف الى متوسط لبعض حبيبات معادن الفلسبار و خاصة البلاجيوكليز الى معدن السيرسيت. و أعزى ذلك الى فعل التجوية الكيميائية لهذه المعادن فى مصادرها الأصلية.

و قد بينت النتائج أن علاقة بعض العناصر مع المعادن المكونة أو الحاملة لها كانت غير معنوية ، وهذا يشير الى أن هذه المعادن ليست المصدر الرئيسى لها، وأن محتوى مياه الرى المختلفة من هذه العناصر و كذلك اضافة الأسمدة أثناء الزراعة لها دور كبير فى إضافتها للتربة.