ORIGINATED SOIL MINERAL CONSTITUENTS AS A FUNCTION OF SUPPLYING POWER CAPACITY FOR NUTRIENTS AT THE MAIN SEDIMENTS OF El FAYOUM DEPRESSION, EGYPT

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ABSTRACT:

The current study is an attempt to define the relationship between originated mineral constituents and essential nutrients that could be derived into the formed soils under cyclic-formation sequences at El Fayoum depression. To achieve this target, four soil sites were selected to represent some soils developed on the main parent materials, i.e., the Nile alluvium, recent lacustrine, desert formations of siliceous (aeolian) and carbonatic in nature (Eocene limestone). The obtained results showed wide variations in the characteristics of the studied soil sites, i.e., topographic-sequence (-40 to +25 m), soil texture grades (sandy to clay), $CaCO_3$ content (1.12 to 38.54%), ground-water table depth (65 to >150 cm), soil salinity (ECe=1.65-23.96 dS/m) and sodicity levels (ESP=3.42-32.68), consequently they differ in their soil taxonomic units and the suitability classes for agricultural purposes. Wetness, soil texture, $CaCO_3$, gypsum and salinity/alkalinity are the most effective limitations for soil productivity, with an intensity degree ranged between slight and very severe (rating >90 and <40). Also, the suitability classes of the studied soils ranged between moderately ($S2_{s1s4}n$) and not suitable ($N1_{ws1s4}$) for the current condition as well as highly ($S1_{s1}$) and marginal suitable ($S3_{s1s4}$).

The polarizing microscopic examination for light and heavy minerals of sand fraction as well as the x-ray diffractions of both silt and clay fractions were also suggested to identify the different nutrient-bearing mineral assemblages. Moreover, soil constituent-bound nutrient forms, i.e., exchangeable, organic matter, carbonate, manganese oxides, amorphous & crystalline iron oxides and the residual content were identified due to their crucial importance for soil fertility status. Most of P amounts in soil were bound with organic matter fraction, with maximum values reached about 26 and 20% of total bound P-forms for both the fluvial sediments and carbonatic desert formation, respectively. The greatest value of K bound with organic matter fraction was about 15% of total bound K-forms for the recent lacustrine sediments. Ca and Mg were more combined with carbonate fraction, especially in the carbonatic desert formation, with greatest values of more than 39 and 68% of the total bound forms, respectively.

Relatively high S-amounts of about 30-31% of the total bound S-forms were bound with organic matter fraction of the Nile alluvial and lacustrine sediments. A pronounced amount of bound micronutrients was more obvious in the Nile alluvial sediments, where Fe was more combined with amorphous and crystalline iron oxide fractions (i. e., about 24 and 40 %, respectively); Mn was more bound with MnO_2 and both iron oxides fractions with maximum values of 23.54 and 30.75 %, respectively; Zn was mostly combined with the amorphous and crystalline iron oxides fractions with about 22 and 37%, respectively; whereas, Cu was also more related to amorphous and crystalline iron oxides fractions (i.e., about 20 and 22 %, respectively) in the recent lacustrine sediments.

The distribution pattern of total macronutrients could be arranged in a descending order of aeolian < carbonatic desert formation < recent lacustrine < Nile allluvial sediments for P and K; aeolian < fluvial < recent lacustrine or carbonatic desert formation for Ca, Mg and S. Total amounts of Fe, Mn, Zn and Cu greatly differed among the studied soil sites; the highest and lowest values were existed in the fluvial and siliceous desert formations, respectively. The relatively highest values of these micronutrients were mainly due to the occurred high contents of organic matter, amorphous or crystalline iron oxides and clay fractions. The available contents of the studied nutrients followed an almost similar trend to that of the total ones, except for phosphorus and micronutrients in the desert formations. This is mainly due to the low contents of organic matter, nutrient bearing minerals and retention or adsorption process in the siliceous desert formation and/or precipitation with $CaCO_3$ in the carbonatic one.

The statistical analysis, using the program of **SPSS (1997),** and obtained data of simple coefficient showed significantly correlations between each of the studied nutrients and some specific bearing-minerals in the different soil mechanical fractions with a contribution percentage. Thus, the final goal of this work was achieved by proposing a simple relationship between the identified mineral nutrient sources and their contribution percentages for nutrients supply in soil sediments under study.

Key words: Soil mineral constituents, released plant nutrients, nutritional problems and soil sediments of El Fayoum.

INTRODUCTION:

Soils of El Fayoum depression are derived and developed on different origins, i.e., the Nile alluvium, lacustrine and desert formations calcareous or siliceous in nature, beside the interference zones between them. So, the nutritional problems in such soils are related not only to the adverse environmental conditions that lead to nutrients deficiency, but also to the wide variations in the nature of the prevailing soil sediments. Thus, identifying more information about the nature of these soil sediments must be carried out, particularly those concerned with nutrient bearing minerals. This will be useful as a guide for successful fertilization system, and in turn it is of vita importance for agricultural utilization programs in El Fayoum Government.

The soil potential for plant nutrient supplying is more related to both soil mineralogical composition and physio-chemical properties. Therefore, the type of minerals besides their ability to weather, which occur either as eroded soil materials or bound in rock fragments, have a great influence on the fertility characteristics of soils **(Ibrahim, 2001)**. On the other side, practices of soil management and moisture regime also influence either dominant nutrient types or the presence of released nutrient forms. The relative abundance of available nutrients and their uptake by roots are largely dependent on pH and aeration condition of the soil **(Lindsay, 1972)**. In that concerning, there are several factors govern the nature of the various nutrient forms derived from the different resources, i.e., a) the character of the composition of the bed-rock or pseudo-eroded soil-mass which depends on the environmental conditions, b) the texture of the soil material, c) the degree of pre-weathering of the parent material and d) duration of both soil formation and the water regime cycles. At the same-time, all these characteristics, that influence directly or indirectly the availability of nutrients for plant, are more related with the vegetative growth and consequently the economic crop yield. Hence, the factors affecting them always acquire the scientific attention of many investigators **(Awadalla, 1998)**.

Abbas *et al.* (2003) reported that the wide range of nutrient contents are apparently associated with soil texture and are probably dependent on type of parent materials from which the soil was derived or formed. It is worthy to note that the dominant pool of mineral soil P occurred in either Ca-bound forms of P in arid and semi-arid regions **(Lajtha and Bloomer, 1988)** or the poorly crystalline Fe phase and the soil clay fraction **(Manu *et al.*, 1991)**. **Awadalla (1993)** suggested that P supply seemed to be of low content in El Fayoum area due to the relatively high $CaCO_3$ content. **Leinweber *et al.* (1997)** demonstrated that the clay size separates had the highest P contents and are particularly enriched in exchangeable and labile forms.

K contents in the majority of soils at Egypt were originated from the primary minerals such as the potash feldspars, i.e., orthoclase, micorcline and sanidine as well as micas, i.e., muscovite, phlogobite, glauconite and biotite **(Assal, 1981)**. It is also found in the secondary minerals, i.e., clays of illite and vermiculite. In general, the mineral K constitutes about 99% of the total potassium in soil, and about 95% of K is within the crystal lattices of the silicate minerals **(Abd El Hamid, 1983). Awadalla (1993)** showed that soil sediments of El Fayoum region are rich in K, except for the desert formations.

Soil calcium and magnesium exist principally in two forms, as carbonates and as exchangeable calcium or magnesium in association with organic and inorganic colloids **(Nadia El-Asser, 1998)**. The availability of both the two nutrients are invariably higher in nearly neutral than in alkaline or strongly alkaline soils, those with pH values above 8.5, because calcium or magnesium are precipitated as carbonate before such high pH values are reached. Thus, calcium and magnesium have buffering effects upon pH **(Cresser *et al.*, 1993)**. Both Ca and magnesium contents in soils of El Fayoum Governorate depend to a large degree on total carbonatic constituents **(Abd Alla and Mohamed, 2001)**.

Although sulfur is an essential nutrient for plant growth, very little work has been done concerning its status in the different soils of Egypt. Most of the studies on soil S has focused on the determination of inorganic sulfate (SO_4^{2-}) in soil, however, its content at any given time does not appear to be a reliable indicator of the amount of S which is likely to become available to the crop during the growing season. **Ali *et al.* (1991)** found that the total S varied according to the clay and organic matter contents, with superiority for the organic form, which represents 71.0-83.0 % of the recorded total content.

Iron is one of the major constituents of the lithosphere, which contains approximately 5% iron. **El Shazly *et al.* (1991)** pointed out that Fe was positively and significantly correlated with most soil variables (clay, clay + silt and organic matter), while it was significantly and negatively correlated with $CaCO_3$. **Awadalla (1993)** found that the highest amount of Fe in El Fayoum soils was associated with the Nile alluvial soils, while the lowest one was found in the desert soils. Also, the available Fe constitutes a small pool of the total content and being in the range of 3.02 to 23.43 mg/kg. **Kamh *et al.* (1995)** showed that the soil under saturation conditions generally increased Fe forms of soluble, exchangeable, complexes and crystalline iron oxides. **Zhang *et al.* (1997)** found that greater than 60 and 80% of total Fe was present in the amorphous and crystalline Fe oxide forms in soils with pH < 6.5 and > 6.5, respectively.

Manganese content present in a soil depends exclusively on the type of rock from which the soils are derived and the processes of weathering, both geochemical and pedochemical. In this respect, the common forms of Mn oxides are birnessite, lithiophorite, and hollandite **(McKenzie, 1977). Awadalla (1993)** found that the highest amount of Mn was associated with the fluvio-lacustrine soils, while the lowest one was found in the desert soils. **Ibrahim (2001)** found that Mn was present predominantly as organically bound forms at pH < 6.5 or as MnO_2 and amorphous associated forms at pH > 6.5. Mn in the soils of El Fayoum Governorate was more related to MnO_2, clay and iron oxide fractions, this relation was more obvious in the Nile alluvial sediments.

Zinc is held in sedimentary rocks partly as adsorbed Zn^{2+} on fine-grained material and partly in the structure of clay minerals in which Zn probably substitutes for Mg^{2+}. In the ferromagnesian minerals of soil, Zn occurs principally in biotite, augite and hornblend **(White, 1957). Awadalla (1993)** found that the highest Zn value in the soils of El Fayoum Governorate was associated with the Nile alluvial soils, while the lowest one was found in the desert soils. In general, the available Zn constitutes a small pool of the total content, and it is in the range of 0.32 to 2.62 mg/kg.

Copper recorded the highest and lowest values in the Nile alluvial and sandy soils, respectively. The calcareous soils showed intermediate values of total Cu due to their low content of organic matter and clay minerals **(Kishk *et al.*, 1973). Awadalla (1993)** found that the highest amount of Cu in the soils of El Fayoum Governorate was associated with the fluvio-lacustrine soils and the lowest one was found in the desert soils, which have the clayey and loamy sand texture grades, respectively. In this connection, Cu was more related to clay and amorphous iron oxides, especially in the Nile alluvium and fluvio-lacustrine sediments **(Ibrahim, 2001)**. On the other hand, the available Cu constitutes a small pool of the total content in these soils.

The current work was an attempt at identifying the relation between originated soil mineral constituents and the released essential plant nutrients as a result of preferential mineral weathering aspects throughout the different cyclic-sequences of the main soil sediments in El Fayoum depression.

MATERIALS AND METHODS:

a. Materials:

Four soil sites were selected at south of Demeshkin (El Fayoum district), west of El Saedia, north of Sinnoris, Ezbet Abdel Karim (Sinnoris district) and El Khalda (Ibshaway district), El Fayoum Governorate to represent soils developed on the main parent materials, i.e., fluvial deposits of the Nile alluvium, recent lacustrine deposits of Qarun lake-shore, desert formations of either siliceous (aeolian or wind blown sand) or carbonatic in nature (Eocene limestone), respectively.

b. Methods of analysis:

Disturbed representative soil samples were collected from the different chosen soil sites according to the morphological variations between the studied sediment origins to determine the physical, chemical and mineralogical properties as well as some plant nutrients as total and available contents in the different soil mineral constituents. The disturbed soil samples were air dried, crushed and sieved through a 2 mm sieve and kept for the following analyses.

* Particle size distribution using the Pipette Method, soil pH in 1:2.5 soil water suspensions, chemical analysis of soil paste extract, cation exchange capacity and exchangeable cations were determined according to the standard methods outlined by **Page *et al.* (1982)**.
* Soil organic matter was determined according to **Walkely and Black** method, **Black *et al.* (1965)**.
* Calcium carbonate content was determined volumetrically by using Calcimeter according to **Avery and Basocomb (1974).**
* Gypsum content in soil was determined by precipitation with acetone according to **Bower and Huss (1948)**.
* Separation of light and heavy minerals from the sand fraction (250-63 micron) was conducted using Bromoform (sp. Gr. 2.85), and mounting of these minerals was undertaken according to the method outlined by **Brewer (1964).** Systematic identification of light and heavy minerals was carried out using the optical properties of about 500 mineral grains for each sample under the polarizing microscope as described by **Milner (1962)**.
* X-ray diffractograms for silt and clay fractions were obtained from oriented samples prepared by allowing 2 mL of a clay-water suspension on dry glass slides and air-dried at the room temperature. The different treated slides of Mg-air dried, Mg-glycerolated and K-heated at 550 C^o were irradiated with Cu Kα radiation of Philips diffractometer. Interpretation of X-ray diffractograms was carried out according to **Schulze (1981)**.
* Amorphous iron oxides fraction was determined in the soil residue (1 g soil + 20 mL of 0.1M $NH_2OH.HCl$, pH 2, shaken, centrifuged and filtered), using 50 mL of $(NH_4)_2C_2O_4.H_2O$ + 0.2M $H_2C_2O_4$, pH 3 **(El Sayad, 1988)**.
* Crystalline iron oxides were determined in the previous soil residue, using 0.1 M ascorbic acid **(Shuman, 1982).**
* Bound nutrient fractions were extracted according to the different procedures outlined by **Shuman (1985).**
* Soil samples were digested to determine the total contents of the studied nutrients. Chemically extractable macro and micronutrients were carried out to identify their available contents, using the analytical methods described by **Black *et al.* (1965) and Soltanpour and Schwab (1977**), respectively. The following equation was applied to calculate the contribution of the different nutrient-bearing minerals by using the statistical analysis conducted by the **SPSS Program (1997):** $Co = \sum (r_n B_n)$

$$Co = r_1 b_1 + r_2 B_2 + r_3 B_3 + \ldots \text{ ext.}$$

Where:

Co = Contribution of nutrient-bearing minerals.
r_4 = Linear regression coefficients of the nutrient-bearing mineral numbers.
B_4 = Standard partial correlations (Beta) of the nutrient-bearing numbers.

RESULTS AND DISCUSSION:

I. A general view on the chosen soil sediments:

It is noteworthy that the representative soil sites are mainly encompassing the different parent material, i.e., fluvial deposits (the Nile alluvium), recent lacustrine deposits (Qarun lake-shore), desert formations characterized by either siliceous (aeolian or wind blown sand) or carbonatic in nature (Eocene limestone), Table (1). These soil sites are formed under climatic conditions of long hot rainless summer and short mild winter, with scare amounts of rainfall. Also, they are developed on different physiographic units, i.e., alluvial terraces, Qarun lakeshore, aeolian plain and old lake terraces. The morphological features (soil colour, texture, structure and consistence) of the studied soil sites exhibit wide variations due to the prevailing wide variations in soil variables. Also, the studied soil media were characterized by various soil elevation, water table depth, textural grade, structure type, pH, salinity or sodicity levels, $CaCO_3$ content and its distribution in the soil mechanical fractions, iron or manganese oxides, CEC, organic matter and gypsum contents, as illustrated in Tables (1 and 2).

Taxonomic units of the studied representative soil sites were identified and named on the basis of soil morphological and physio-chemical characteristics at the family level according to **Soil Survey Staff (1999)** as Typic Haplotorrerts, clayey, smectitic, hyperthermic for the Nile alluvial, Aquic Torriorthents, fine loamy, mixed, hyperthermic for the recent lacustrine, Typic Torripsamments, siliceous, hyperthermic for the siliceous desert formation and Typic Haplocalcids, clayey, mixed, hyperthermic for the carbonatic desert formation.

Table (1): Some morphological features of the studied soil sediments.

Physiographic Unit	Soil colour			Texture class	Soil structure	Soil consistence		
	Hue	Dry	Moist			Dry	Moist	Wet
Fluvial deposits (the Nile alluvium)								
Alluvial terraces	10YR	5/2	4/2	c	sbk	ha	fir	stpl
Recent lacustrine deposits								
Qarun lake shore	10YR	6/2	5/3	scl	sbk	sha	fr	sstpl
Desert formation (siliceous in nature)								
Aeolian plain	10YR	7/3	6/4	s	sg	lo	fr	nstpl
Desert formation (carbonatic in nature)								
Old lake terraces	10YR	8/3	7/4	c	anb	vha	vfir	vstpl

Soil texture: s = sand, scl = sandy clay loam and c = clay
Soil structure: sbk = sub angular blocky, anb = angular blocky and sg = single grain
Soil consistence: Dry: lo = loose, sha = slightly, ha == hard and vha = very hard
Moist: fr = friable, fir = firm and vfir = very firm
Wet: nstpl = non sticky & non plastic, sstpl = slightly sticky & slightly plastic, stpl = sticky & plastic and vstpl = very sticky & very plastic

Table (2): Some characteristics of the studied soil sediments.

Soil properties	The Nile alluvium	Recent lacustrine	Desert formations	
			Siliceous	Carbonatic
Particle size distribution %:				
Sand	18.40	52.30	93.10	29.40
Silt	32.70	19.20	2.60	27.90
Clay	48.90	28.50	4.30	42.70
Soil texture class	Clay	SCL*	Sand	Clay
$CaCO_3$ %	3.45	11.87	1.12	38.54
$CaCO_3$ distribution in the different soil mechanical fractions %:				
Sand	0.48	2.80	0.26	9.55
Silt	0.93	3.75	0.37	16.13
Clay	2.04	5.32	0.49	12.86
Iron oxides %:				
Crystalline	1.328	1.097	0.325	0.659
Amorphous	0.314	0.406	0.072	0.375
MnO_2 %	0.047	0.041	0.005	0.029
ECe (dS/m, soil paste extract)	2.38	23.96	1.65	6.47
Soluble ions (m molc L^{-1}):				
Ca^{2+}	7.65	10.93	5.26	19.18
Mg^{2+}	5.70	27.62	3.45	14.72
Na^{+}	10.50	204.35	8.03	30.70
K^{+}	0.40	1.85	0.15	0.75
CO_3^{2-}	0.00	0.00	0.00	0.00
HCO_3^{-}	2.50	3.95	1.85	2.85
Cl^{-}	12.55	128.75	8.25	33.45
SO_4^{2-}	9.20	112.05	6.79	29.05
pH (1.:2.5 soil water suspension)	7.84	8.90	7.52	8.36
CEC (c molc kg^{-1})	39.84	21.72	5.67	19.05
ESP	10.83	32.65	3.42	12.05
Organic matter %	2.63	1.87	0.12	0.94
Gypsum %	0.27	1.53	0.09	2.84
Elevation of soil surface (m)	+ 25	- 30	- 40	-30
Depth of ground water table (m)	> 150	65	120	140

* Sandy clay loam

Also, according to a parametric system undertaken by **Sys and Verheye (1978)**, the intensity degrees of soil limitations and suitability categories for the studied soils were calculated and presented in Table (3).

It is clear from data obtained that wetness, soil texture (s_1), $CaCO_3$ (s_3), gypsum (s_4) and salinity/alkalinity (n) are the most effective limitations for soil productivity, with an intensity degree for each of soil limitations lies in the range of slight-very severe (rating >90 - <40). Also, the suitability classes of the studied soils could be ranged between moderately ($S_2s_1s_4n$) and not suitable ($N_1ws_1s_4$) for the current condition as well as highly (S_1s_1) and marginally suitable ($S_3s_1s_4$).

II. Soil mineralogical constituents:

The knowledge of the mineralogical constituents as related to both nutrients released and their availability in soils is important for predicting their behavior in soil-plant system.

a. Sand as a coarse fraction:

Significance of nutrient bearing minerals as an aspect of soil fertility evaluation can be achieved throughout identifying the mineral constituents of the primary and secondary minerals in the main soil mechanical fractions of sand, silt and clay. The expected released nutrients depend upon the mineralogical composition of these originated mineral constituents and their ability to weather under active chemical weathering, intensive cropping system and management practices

Table (3): Soil limitations and rating indices for the evaluation of the studied soil sites at El Fayoum Governorate.

Sediment Type	Suitability condition	Topography (t)	Wetness (w)	S				Soil salinity/ Alkalinity (n)	Rating (Ci)	Suitability class	Suitability subclass
				Soil texture (s1)	Soil depth (s2)	$CaCO_3$ (s3)	Gypsum (s4)				
The Nile alluvium	Current	100	100	85	100	100	90	90	68.85	S2	S2s1s4n
	Potential	100	100	85	100	100	90	100	76.50	S1	S1s1s4
Recent lacustrine	Current	100	55	95	100	100	100	58	30.31	S3	S3ws1n
	Potential	100	100	95	100	100	100	100	95.00	S1	S1s1
Siliceous formation	Current	100	90	30	100	100	90	100	24.30	N1	N1ws1s4
	Potential	100	100	30	100	100	90	100	27.00	S3	S3s1s4
Carbonatic formation	Current	100	80	85	100	90	100	80	48.96	S3	S3ws1s3n
	Potential	100	100	85	100	90	100	100	76.50	S1	S1s1s3

Polarizing microscopic examination of sand as a coarse fraction, Table (4), reveal that the nutrients bearing minerals assemblage are both the feldspars (orthoclase, anorthite and plagioclase) and mica (muscovite and biotite) as light minerals, where they represent the main sources for K, Ca, Mg and Fe. A relatively high content of these minerals is associated with the carbonatic desert formation, which reflects their potentiality for nutrients supply. Whereas, the other studied soil sediments could be arranged in an ascending order as follows: recent lacustrine > the Nile alluvium > siliceous desert formation.

On the other hand, the heavy minerals are dominated by opaques (as a source of Fe) or non-opaques, i.e., pyroxenes, amphiboles (less stable minerals and as sources of Ca, Mg and Fe), epidotes (Ca and Fe) and biotite (K, Mg and Fe). Also, carbonatic desert formation and the Nile alluvial sediments comprised a relatively high portion of the heavy minerals (either opqaques or non-opaques), this emphasis that these soil media mostly contribute to a nutrients store and explicit renewal source to supply these nutrients which can be released viz chemical weathering on the long run. Chlorite, sephene, olivine (as a source of Ca, Mg and Fe) and apatite (as a source of P and Ca) are associated with the recent lacustrine and carbonatic desert formations. The more resistant heavy minerals (tourmaline and garnet) are associated mainly with the siliceous desert formation; reflecting the excessive chemical weathering under the prevailing past wet condition.

Table (4): Frequency distribution of nutrient bearing minerals in the light and heavy fractions of the studied soil sediments.

Mineral assemblage		The Nile alluvium	Recent lacustrine	Desert formations	
				Siliceous	Carbonatic
Light minerals %					
Feldspars	Orthoclase	11.42	14.08	6.45	16.03
	Anorthite	9.78	11.64	4.70	13.25
	Plagioclase	5.54	7.29	3.35	11.08
Micas	Muscovite	3.61	5.35	1.58	4.75
	Biotite	6.17	8.92	0.74	7.34
Others		63.48	52.72	83.18	52.30
Heavy minerals %					
Opaques	Iron oxides	54.82	46.60	51.41	63.18
Non opaques	Pyroxenes	17.46	14.75	8.95	19.50
	Amphiboles	16.19	13.85	10.20	17.91
	Epidotes	19.40	15.67	14.83	18.87
	Tourmaline	3.09	5.10	8.74	7.50
	Garnet	1.15	2.72	6.83	4.02
	Chlorite	4.60	5.23	2.19	6.50
	Mica biotite	12.13	6.47	2.80	9.15
	Sephene	0.69	1.05	2.48	3.90
	Olivine	2.80	3.79	0.41	4.75
	Apatite	1.45	3.80	1.85	4.64
	Others	21.04	27.57	40.72	3.26

b. Silt and clay as a fine fraction:

Data in Table (5) indicate that the nutrient bearing minerals in silt fraction are predominated in the Nile alluvial sediments by coarse clays (kaolinite, illite and chlorite, as a source of K, Mg and micronutrient), beside iron forms (hematite and magno-ferrite as sources of Fe and Mn), Meanwhile, calcic mineral such as calcite, dolomite and gypsum (as a source of Ca, Mg and S), in addition to iron forms (hematite, pyrite and magno-ferrite as sources of Fe, S and Mn), baricite (as a source of Mg, P and Fe) and palygorskite (as a source of Mg) represent the dominant nutrient bearing minerals in the sediments of recent lacustrine and carbonatic desert formation. Feldspars and hydrous mica (as a source of K, Mg and Fe) constitute reasonable portions in most of the studied silt fraction in the siliceous desert formation.

Concerning the nutrient bearing minerals in clay fraction, data reveal that smectites (as a source of micronutrients) are the most dominant minerals in all the selected samples of clay fractions, especially in the Nile alluvial sediments, which possess also a pronounced amount of both illite (as a source of K) and iron forms (hematite and magno-ferrite, as a source of Fe and Mn), as shown in Table (5). Palygorskite, calcic, baricite, pyrite and magno-ferrite minerals (as a source of Mg, Ca, P, S, Fe and Mn) are associated mainly with the sediments of recent lacustrine and carbonatic desert formation. Beside the dominance of smectites in the siliceous desert formation, kaolinite, illite, and feldspars also occur in pronounced amounts as nutrients bearing minerals.

Table (5): Semi quantitative analysis of nutrient bearing minerals in the silt and clay fractions of the studied soil sediments.

Mineral assemblage		The Nile alluvium	Recent lacustrine	Desert formations	
				Siliceous	Carbonatic
Silt fraction					
Clay minerals	Smectite	--	--	--	--
	Kaolinite	18.38	7.54	2.92	5.41
	Hydrous mica	16.15	5.74	17.82	1.25
	Vermiculite	1.82	2.47	0.71	3.55
	Palygorskite	0.55	10.73	0.89	12.96
	Chlorite	8.27	9.15	2.86	8.74
Accessory minerals	Feldspars	3.56	7.25	26.42	7.67
	Calcite	2.03	10.14	2.84	27.40
	Dolomite	1.36	6.76	1.89	16.44
	Baricite	1.53	12.90	2.14	11.69
Iron forms	Hematite	4.65	10.45	5.80	9.25
	Pyrite	0.59	3.24	0.35	3.63
	Magno-ferrite	6.10	9.50	4.62	6.85
Others		35.01	4.13	30.74	1.60
Clay fraction					
Clay minerals	Smectite	58.35	24.50	35.97	7.84
	Kaolinite	5.85	8.85	12.64	15.92
	Illite	9.39	6.17	9.50	6.76
	Vermiculite	4.01	2.95	0.71	6.25
	Palygorskite	0.45	12.18	0.66	13.93
	Chlorite	0.81	2.25	1.12	4.97
Accessory minerals	Feldspars	2.15	3.05	15.92	4.73
	Calcite	0.91	5.94	0.83	6.08
	Dolomite	0.60	3.96	0.55	4.06
	Baricite	1.97	8.02	3.11	8.60
Iron forms	Hematite	7.34	2.74	4.03	6.81
	Pyrite	2.12	9.76	2.93	4.40
	Magno-ferrite	5.30	8.37	1.45	8.09
Others		0.75	1.26	10.58	1.56

III. Soil constituent-bound nutrients:

a. Soil constituent:

Nutrients can be bound by various soil constituents, especially those of active charged surface, which play an important role in the soil fertility aspects, such as organic matter, carbonate, manganese oxide, soil mechanical fractions, amorphous and crystalline iron oxides. Data illustrated in Table (2) show that the studied soil sediments are characterized by low organic matter inputs ranged 0.12-2.63%. Mn oxide content (0.005-0.047%) is usually associated with Fe oxides in amorphous and crystalline forms (0.397-1.642%). The MnO_2 content was relatively low in the desert formations whether siliceous or carbonatic in nature, however, it tends to increase in the recent lacustrine and fluvial sediments. The distribution patterns of organic matter, MnO_2 and amorphous iron oxides among the studied soil sediments followed an ascending order: siliceous desert formation < carbonatic desert formation < recent lacustrine < the Nile alluvium.

Soil calcium carbonate could be grouped into three categories, i.e., relatively low content (<5 %, the siliceous desert formation and fluvial sediments), moderate content (> 10 to <25 %, the recent lacustrine sediments) and relatively high content (>25 %, the carbonatic desert formation). Mechanically, it acts as active form in the Nile alluvium, recent lacustrine, siliceous desert formation, due to the dominance of chemical weathering process, while it is more associated with the medium size (silt fraction) in the carbonatic desert formation.

b. Bound nutrient fractions:

Data obtained in Table (6) show that most of P amounts in the studied soils were bound with organic matter and carbonate fractions, with maximum values reached about 26 and 20% of total bound P-forms for both the fluvial sediments and carbonatic desert formation, respectively. Also, the maximum values of bound K-fractions were about 13, 15 and 13% of total bound K-forms for exchangeable, organic matter and carbonate fractions of the fluvial, recent lacustrine and carbonatic desert sediments, respectively. Ca and Mg were more combined with carbonate fraction, especially in the carbonatic desert formation, with maximum values of more than 39 and 68% of the total bound Ca and Mg-forms, respectively.

As for S distribution, relatively high amounts of about 30-31% of the total bound S-forms were bound with organic matter fraction of the Nile alluvial and lacustrine sediments. However, the lowest ones were found in both the S-exchangeable and carbonate forms in all the studied soil sediments, except for the carbonatic desert formation, where the bound S-fraction reached about 14% of total bound S-forms. Concerning the micronutrients, it is noteworthy that Fe was more combined with amorphous and crystalline iron oxide fractions of the fluvial sediments (about 24 and 40%, respectively). Mn was more related to MnO_2 and both iron oxides fractions, with maximum values of 23.54 and 30.75%, respectively, of total bound Mn-forms in the fluvial sediments. Zn was mostly combined with the amorphous and crystalline iron oxides fractions with about 22 and 37%, respectively, of total bound Zn-forms in the fluvial sediment. Also, Cu was more related to amorphous and crystalline iron oxides fractions (i.e., about 20 and 22%, respectively) in the recent lacustrine sediments.

IV. Nutrients status:

a. Total contents:

Soil productivity is generally judged by its capacity to supply plant with nutrients through the occurrence of nutrient-bearing minerals and their ability to weather. Hence, the clear information about the status of macro and micronutrients as related to the nature of soil mineral constituents has a vital importance and is considered a useful guide for planning the policy of fertilization system. The data obtained in Table (6) indicate that the distribution pattern of total P could be arranged in an ascending order of aeolian < carbonatic desert formation < recent lacustrine < fluvial sediments. The highest total K value also was obtained from the fluvial deposits due to the occurrence of relatively high content K-bearing minerals, i.e., feldspars, micas and illite in silt and clay fractions, while the lowest one was related to the aeolian sediment. Total Ca and Mg contents recorded the highest and lowest values at the desert formations of carbonatic and siliceous in nature, respectively. The highest Ca and Mg-values were mainly attributed to the occurrence of relatively high content of bound Ca and Mg-carbonate, palygorskite, baricite, calcite and dolomite in silt and clay fractions.

Table (6): Distribution of macro and micronutrients among the different constituents of the studied soil sediments.

Soil sediment	Macro and micronutrients distribution among the different soil constituents (mg/kg soil)							
	Exch.	C.B.	O.M.	MnO	Am. FO	Cry. FO	Residual	Total
				P				
Nile alluvium	0.31	2.17	252.54	154.13	73.56	109.74	371.29	964.24
Lacustrine	0.24	106.08	172.92	86.75	33.97	46.12	295.27	741.35
Silic. desert	0.10	1.69	48.64	27.91	14.06	17.80	170.73	280.93
Carbo. Desert	0.12	140.54	96.75	37.55	31.41	46.53	352.08	704.98
				K				
Nile alluvium	1497.15	34.64	928.07	789.16	465.70	548.38	7240.30	11503.40
Lacustrine	486.47	168.80	1399.94	506.90	297.14	362.75	5937.54	9159.54
Silic. desert	189.39	22.75	62.56	134.24	59.65	75.12	2633.10	3173.81
Carbo. Desert	351.68	887.11	609.81	158.65	178.93	281.90	4221.54	6689.62
				Ca				
Nile alluvium	1930.88	2527.31	1312.84	722.05	503.60	544.25	13307.53	20848.46
Lacustrine	2567.41	9511.72	1584.33	474.16	395.58	405.74	20731.71	35670.65
Silic. desert	932.52	853.09	569.65	94.85	87.74	93.95	2604.76	5236.56
Carbo. Desert	2987.93	41297.6	1153.72	7234.84	284.73	312.83	51269.71	104541.36
				Mg				
Nile alluvium	1172.51	1674.11	1201.75	817.90	282.45	301.05	2064.39	7517.16
Lacustrine	1390.70	4256.34	895.92	596.54	171.19	198.82	4471.44	11980.95
Silic. desert	295.83	603.75	186.63	125.50	59.87	60.61	1380.90	2713.09
Carbo. Desert	678.42	12697.7	534.45	376.23	113.65	152.53	3976.83	18529.81
				S				
Nile alluvium	0.17	1.73	215.67	98.01	60.35	78.84	256.59	711.36
Lacustrine	0.19	4.91	193.42	64.82	41.74	54.13	262.24	621.45
Silic. desert	0.08	0.88	32.84	18.75	9.97	13.65	100.66	176.83
Carbo. Desert	0.11	78.45	91.09	61.93	33.81	39.07	249.91	554.37
				Fe				
Nile alluvium	1.38	12.93	1.91	617.68	5897.75	9792.6	8077.40	24401.65
Lacustrine	1.14	32.12	1.15	93.15	2685.1	5487.7	4748.10	12935.90
Silic. desert	0.89	4.84	0.26	48.94	117.15	512.93	712.55	1397.56
Carbo. Desert	0.67	89.57	0.73	67.87	1314.1	2053.5	11502.19	11566.75
				Mn				
Nile alluvium	0.91	1.29	1.58	68.31	50.32	38.90	128.82	290.13
Lacustrine	0.67	3.62	1.11	35.02	40.17	35.87	94.32	210.78
Silic. desert	0.18	0.78	0.39	13.95	13.19	2.66	39.77	70.92
Carbo. Desert	0.46	7.54	0.72	26.01	39.85	22.75	81.30	178.63
				Zn				
Nile alluvium	0.48	0.79	1.95	2.05	27.42	45.68	45.37	123.74
Lacustrine	0.37	1.52	1.27	1.82	16.55	22.55	39.48	83.56
Silic. desert	0.12	0.43	0.29	0.96	10.93	13.08	8.79	34.60
Carbo. Desert	0.35	4.07	0.82	1.35	19.75	21.95	28.65	76.94
				Cu				
Nile alluvium	0.41	0.65	1.08	1.15	14.74	13.91	44.31	76.25
Lacustrine	0.32	6.19	0.99	0.87	12.82	14.27	26.32	62.78
Silic. desert	0.18	0.38	0.21	0.52	0.05	2.78	13.39	17.51
Carbo. Desert	0.24	8.94	0.77	0.92	9.69	8.20	20.92	49.68

Ex=Exchangeable, C.B.=Carbonate bound, O.M.=Organic matter, Am.=Amorphous and Cry.=Crystalline

Total S occurring a relatively high content at the lacustrine sediment; the reverse was true at the aeolian one. The rest soil sediments could be arranged in the order of the carbonatic desert formation < the fluvial sediments. The highest values of S are mainly attributed to the occurrence of a relative high content of pyrite (13.0 %, in the silt and clay fractions), in addition to a pronounced amount for each of soil organic matter (1.87 %), gypsum (1.53 %) and SO_4^{2-} (112.05 m mol_c L^{-1}). Total amounts of Fe, Mn, Zn and Cu greatly differed among the studied soil sites; the highest and lowest values were existed in the fluvial and siliceous desert formations, respectively. The recorded highest values of these micronutrients were mainly due to the occurrence high contents of organic matter, amorphous or crystalline iron oxides, magno-ferrite and clay fractions.

b. Available contents:

Data in Table (7) reveal that the distribution pattern of available P was almost similar to that obtained for the total amounts, where the highest available P content was found in the Nile alluvial deposits, while the lowest ones are associated with the desert formations either the siliceous or carbonatic in nature, presumably due to the low contents of organic matter, P bearing mineral and retention or adsorption in the siliceous and/or precipitation with $CaCO_3$ in the carbonatic one. The available amounts of K were greatly affected by the total contents and did not exceed 5 % of the total K contents. The relatively high amounts of available K in the fluvial deposits are mainly attributed to the relatively high contents of bound K-organic matter, exchangeable, Mn- and F-oxide fractions. The available amounts of Ca and Mg were affected by their total contents and represented about 7-12% of their total contents. The highest and lowest values followed a similar trend to that of total Ca-content, where the higher amounts were mainly attributed to the higher contents of bound Ca & Mg-carbonate, Ca & Mg-exchangeable and Ca & Mg-clay fraction, since the available Ca and Mg were about 1.5-10.0% of their total contents.

Table (7): Available nutrient contents (mg/kg) of the studied soil sediments.

Nutrient	The Nile alluvium	Recent lacustrine	Desert formations	
			Siliceous	Carbonatic
P	14.36	7.80	3.92	4.68
K	589.70	349.83	65.42	201.07
Ca	727.56	974.95	385.12	1486.18
Mg	954.75	687.63	211.84	1921.24
S	291.07	372.55	56.70	187.63
Fe	18.54	5.44	4.34	3.69
Mn	7.65	2.12	0.97	0.85
Zn	3.09	1.47	0.71	0.68
Cu	2.47	1.31	0.65	0.59

The available S followed a similar trend to that of total S contents, representing about 32-60 % of the total S content. Its distribution in the other soil sediments is subjected to the order of the fluvial deposits > carbonatic desert formation. The markedly reduction of available S in both the desert formations of siliceous and carbonatic in nature may be related to the relatively low S-bearing mineral and the relatively high $CaCO_3$ content, by which it was fixed with a strong binding, respectively **(Ibrahim, 2001)**. The available content for each of the studied micronutrients represents a very small fraction of the total amounts. The relatively high amounts of these available micronutrients are probably due to the relatively high content of those occurred in exchangeable and bound with organic matter fractions.

In general, the desert formations are characterized by relatively lower contents of available nutrients. As for the siliceous desert formation (aeolian deposits), this is probably due to the relatively coarse texture grade which is poor in nutrient bearing minerals, organic component, inorganic active charged materials that play an important role in nutrients retention as well as soil fertility status. Whereas, the reduction in the amounts of available nutrients, especially P, Fe, Mn, Zn and Cu in the carbonatic desert formation may be attributed to the occurrence of relatively high $CaCO_3$ content and soil pH which restrict their availability in soils and their mobility towards plant roots.

V. Calculating the contribution percentages of the released nutrients from the studied bearing-minerals:

A trial was done to clarify an approach for calculating the contribution percentages of the released nutrients from the studied bearing-minerals by using the statistical analysis conducted by using the **SPSS program (1997)** and the obtained data of linear regression coefficient and multiple regressions between some bearing-minerals in the different soil mechanical fractions (Tables 4 &5) and total nutrient contents in the soil mechanical fractions (Table 8).

Table (8): Distribution of total nutrients among soil mechanical fractions of the studied soil sediments.

Soil sediment	Soil mechanical fractions	Nutrient content (mg/kg)								
		P	K	Ca	Mg	S	Fe	Mn	Zn	Cu
The Nile alluvial	Sand	137.76	1637.90	3028.29	1070.69	60.11	3391.83	40.32	17.20	10.59
	Silt	267.23	3181.53	5882.28	2079.76	116.76	6588.45	78.34	33.41	20.82
	Clay	584.94	6964.02	12875.66	4552.38	255.58	14421.37	171.47	73.13	45.05
Recent lacustrine	Sand	183.25	2211.59	8560.99	2884.14	146.66	3052.88	49.74	19.72	14.82
	Silt	245.36	2961.29	11463.03	3861.81	196.37	4087.75	66.61	26.40	19.84
	Clay	347.86	4198.30	16251.39	5474.98	278.41	5795.29	94.43	37.43	28.13
Siliceous formation	Sand	42.55	746.74	1246.42	629.44	41.02	324.23	16.45	8.03	4.06
	Silt	60.52	1062.17	1772.93	895.31	58.35	461.19	23.40	11.42	5.87
	Clay	80.33	1409.79	2353.14	1188.33	77.45	612.13	31.06	15.15	7.67
Carbonatic formation	Sand	182.70	1696.53	26761.21	4677.81	137.48	2868.55	44.30	19.08	12.32
	Silt	307.93	2859.47	45105.58	7884.38	231.73	4834.90	74.67	32.16	20.76
	Clay	246.05	2284.84	36041.31	6299.96	185.16	3863.29	59.66	25.70	16.56

Data of simple mathematical functions and those are presented in Table (9) reveal that there are positive and significant correlation coefficients between the studied nutrients and some bearing-minerals in the different soil mechanical fractions. Also, the more easily and final mathematical models which can be used for calculating the contribution percentages of the studied nutrient bearing minerals for all the studied soil sediments are presented in Table (10).

Table (9): Simple correlation coefficients between total amounts of nutrients and mineral assemblages of soil mechanical fractions.

Mineral	Nutrients								
	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu
Sand fraction									
Light minerals									
Orthoclase	--	0.913**	--	--	--	--	--	--	--
Anorthite	N.S.	--	0.939**	--	--	--	--	--	--
Plagioclase	--	--	0.609*	--	--	--	--	--	--
Muscovite	--	0.522*	--	--	--	--	--	--	--
Biotite	--	N.S.	--	0.5.62*	--	0.546*	--	--	--
Heavy minerals									
Iron oxides	--	--	--	--	0.957**	0.989**	0.685*	0.598*	0.776*
Pyroxenes	--	--	0.789*	0.599*	--	--	--	--	--
Amphiboles	--	--	0.545*	0.683*	--	--	--	--	--
Epidotes	--	--	--	--	--	N.S.	--	--	--
Tourmaline	--	--	--	--	--	--	0.597*	0.704*	N.S.
Garnet	--	--	--	--	--	--	--	--	--
Chlorite	--	--	--	0.647*	--	0.605*	0.612*	N.S.	0.578*
Mica biotite	--	0.913**	--	0.584*	--	0.776*	0.525*	N.S.	0.695*
Sephene	--	--	0.656*	--	--	--	--	--	--
Olivine	--	--	--	0.595*	--	0.757*	--	N.S.	--
Apatite	0.903**	--	0.584*	--	0.569*	--	--	--	--
Carbonates	N.S.	N.S.	0.978**	0.915**	0.613*	--	--	--	--
Silt fraction									
Smectites	--	--	--	--	--	--	--	--	--
Kaolinite	--	--	--	--	--	--	--	--	--
Illite	--	0.983**	--	--	--	--	--	--	--
Vermiculite	--	--	--	0.611*	--	--	--	--	--
Palygorskite	--	--	0.675*	0.933**	--	--	--	--	--
Chlorite	--	--	--	0.654*	--	--	--	--	--
Feldspars	--	0.974**	--	--	--	--	--	--	--
Calcite	--	--	0.959**	--	--	--	--	--	--
Gypsum	--	--	0.602*	--	0.969**	--	--	--	--
Dolomite	0.633*	--	0.952**	0.793*	--	--	0.576*	N.S.	N.S.
Baricite	N.S.	--	--	0.934**	--	0.570*	--	--	0.612*
Pyrite	--	--	--	--	0.957**	0.982**	--	--	--
Magnoferrite	0.579*	--	--	--	--	N.S.	0.764*	0.594*	N.S.
Iron oxides	0.970**	N.S.	--	--	--	0.995**	0.576*	0.987**	0.997**
Carbonates	N.S.	N.S.	0.986**	0.795*	0.572*	--	N.S.	N.S.	0.627*
Clay fraction									
Smectites	--	--	N.S.	--	--	0.615*	0.648*	0.739*	0.695*
Kaolinite	0.785*	--	--	--	0.547*	--	--	--	0.587*
Illite	--	0.913**	--	--	--	--	--	--	0.693*
Vermiculite	0.714*	--	0.985**	0.963**	--	0.697*	0.612*	0.967**	0.968**
Palygorskite	0.587*	--	--	0.568*	0.547*	N.S.	0.667*	0.594*	0.650*
Chlorite	--	--	0.639*	0.949**	--	--	--	--	N.S.
Feldspars	--	0.578*	0.642*	--	--	--	--	--	--
Calcite	--	--	0.689*	--	--	--	--	--	--
Gypsum	--	--	0.634*	--	0.733*	--	--	--	--
Dolomite	0.601*	--	0.685*	0.599*	0.632*	--	--	--	--
Baricite	--	--	--	N.S.	N.S.	--	0.787*	0.697*	0.785*
Pyrite	--	--	--	--	0.983*	0.968**	--	--	--
Magnoferrite	0.517*	--	--	--	--	0.635*	0.995**	0.752*	0.591*
Iron oxides	--	--	--	--	--	0.596*	0.714*	--	0.593*
Carbonates	N.S.	N.S.	0.579*	N.S.	N.S.	--	--	--	--

Table (10): Contribution percentages of the different mineral assemblages of soil mechanical fractions to the studied nutrients.

Mineral source	Nutrients								
	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu
Sand fraction									
Light minerals									
Orthoclase	--	17.45	--	--	--	--	--	--	--
Anorthite	8.53	--	9.53	--	--	--	--	--	--
Plagioclase	--	--	622	--	--	--	--	--	--
Muscovite	--	13.90	--	--	--	--	--	--	--
Mica biotite	--	8.12	--	9.29	--	8.81	--	--	--
Heavy minerals									
Iron oxides	--	--	--	--	52.34	46.28	47.69	36.19	40.40
Pyroxenes	--	--	9.75	12.66	--	--	--	--	--
Amphiboles	--	--	12.64	8.05	--	--	--	--	--
Epidotes	--	--	--	--	--	9.37	--	--	--
Tourmaline	--	--	--	--	--	--	9.24	12.09	9.55
Garnet	--	--	--	--	--	--	--	--	--
Chlorite	--	--	--	16.80	--	5.14	17.72	10.20	19.75
Mica biotite	--	53.80	--	6.67	--	16.15	25.35	31.87	30.30
Sephene	--	--	5.14	--	--	--	--	--	--
Olivine	--	--	--	13.42	--	14.25	--	6.65	--
Apatite	81.65	--	13.95	--	31.92	--	--	--	--
Carbonates	9.82	6.73	42.77	33.16	15.74	--	--	--	--
Silt fraction									
Smectites	--	--	--	--	--	--	--	--	--
Kaolinite	--	--	--	--	--	--	--	--	--
Illite	--	41.53	--	--	--	--	--	--	--
Vermiculite	--	--	--	9.47	--	--	--	--	--
Palygorskite	--	--	6.10	15.79	--	--	--	--	--
Chlorite	--	--	--	10.53	--	--	--	--	--
Feldspars	--	43.84	--	--	--	--	--	--	--
Calcite	--	--	11.65	--	--	--	--	--	--
Gypsum	--	--	17.54	--	48.31	--	--	--	--
Dolomite	18.55	--	9.26	36.60	--	--	17.84	8.28	7.81
Baricite	7.13	--	--	9.72	--	9.92	--	--	23.63
Pyrite	--	--	--	--	14.04	37.23	--	--	--
Magnoferrite	12.75	--	--	--	--	5.15	25.37	24.69	8.11
Iron oxides	53.20	8.38	--	--	--	47.70	49.16	57.01	50.94
Carbonates	8.37	6.25	55.45	17.89	37.65	--	7.63	10.02	9.51
Clay fraction									
Smectites	--	--	8.84	--	--	26.99	9.02	23.61	27.52
Kaolinite	43.44	--	--	--	27.53	--	--	--	--
Illite	--	60.83	--	--	--	--	--		--
Vermiculite	14.06	--	36.62	33.81	--	13.67	28.72	45.54	43.98
Palygorskite	12.66	--	--	10.76	--	9.59	10.31	10.44	
Chlorite	--	--	12.26	30.85	--	--	--	--	
Feldspars	--	32.56	6.83	--	--	--	--	--	--
Calcite	--	--	11.87	--	--	--	--	--	--
Gypsum	--	--	8.45	--	14.09	--	--	--	--
Dolomite	24.85	--	7.82	11.04	9.38	--	--	--	--
Baricite	--	--	--	6.49	5.89	--	7.87	12.95	21.46
Pyrite	--	--	--	--	36.04	28.01	--	--	--
Magnoferrite	9.20	--	--	--	--	9.88	35.11	--	7.04
Iron oxides	--	--	--	--	--	11.95	8.97	7.45	
Carbonates	5.78	6.61	7.32	7.05	7.07	--	--	--	--

From the obtained data, it is noteworthy that phosphorus mainly correlated with apatite (sand), iron oxides (silt) and kaolinite & dolomite (clay). Potassium mainly correlated with mica (sand), feldspars & illite (silt) and illite & feldspars (clay). Calcium mainly correlated with $CaCO_3$ (sand and silt) and vermiculite (clay). Magnesium mainly correlated with $CaCO_3$ (sand), dolomite (silt) and vermiculite & chlorite (clay). Sulphur mainly correlated with iron oxides & apatite (sand), gypsum & $CaCO_3$ (silt) and kaolinite & pyrite (clay). Iron mainly correlated with iron oxides (sand), iron oxides & pyrite (silt) and smectite & pyrite (clay).

Manganese mainly correlated with iron oxides & mica biotite (sand), iron oxides & magno-ferrite (silt) and smectite & magno-ferrite (clay). Zinc mainly correlated with iron oxides & mica biotite (sand), iron oxides & magno-ferrite (silt) and smectite & vermiculite (clay). Copper mainly correlated with iron oxides & mica biotite (sand), iron oxides & baricite (silt) and smectite & vermiculite (clay).

It could be concluded that the contribution percentages of the released nutrients from the studied bearing-minerals of different soil mechanical fractions are considered good criteria for evaluating inert status of soil fertility. Consequently, the measurements of soil mineral constituents are of the importance for planning soil fertility under the different soil sustaining systems as well as for monitoring the applied fertilization policies concerning with maximizing the nutrients supplying power capacity of the soils differ in their origins.

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مكونات التربة المعدنية الموروثة كدالة للقدرة الإمدادية بالمغذيات فى الرسوبيات الرئيسية لمنخفض الفيوم – مصر

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هذه الدراسة تعتبر محاولة لإيجاد العلاقة بين المكونات المعدنية الموروثة والمغذيات الضرورية والتى يمكن إنطلاقها فى دورات التكوين المتعاقبة فى منخفض الفيوم، ولتحقيق ذلك تم إختيار أربعة مواقع أرضية تمثل بعض الأراضى المتكونة على مواد الأصل الرئيسية (النهرية الرسوبية، البحيرية الحديثة، التكوينات الصحراوية ذات الطبيعة السليكاتية والجيرية وكلتاهما تنتمى إلى الرسوبيات الريحية والصخر الجيرى الأيوسينى) . وتبين النتائج المتحصل عليها أن هناك تباين كبير فى خواص المواقع الأرضية تحت الدراسة ممثل فى تتابع إنحدار سطح الأرض (-٤٠ إلى +٢٥ م)، قوام التربة (رملى - طينى)، المحتوى من $CaCO_3$ (١.١٢-٣٨.٥٤٪)، عمق الماء الأرضى (٦٥ إلى أكثر من ١٥٠سم)، ملوحة التربة (١.٦٥-٢٣.٩٦ ديسيسيمنز/م)، مستوى الصودية (ESP=3.42-32.68)، ومن ثم فانها تختلف فى وحداتها التقسيمية ودرجات صلاحيتها فى المجالات الزراعية. كما تمثل عوامل الترطيب، قوام التربة، والمحتوى من كربونات الكالسيوم والجبس، والملوحة والقلوية أهم المحددات لإنتاجية التربة بدرجات شدة تتراوح بين بسيطة-شديدة جدا (>٩٠-<٤٠)، وتراوحت درجات الصلاحية بصورتها الحالية ما بين متوسطة (S2s1s4n) إلى غير صالحة (N1ws1s4)، وتصل بقدرتها الكامنة إلى عالية الصلاحية (S1s1)، هامشية أوحدية الصلاحية (S3s1s4).

وقد أستخدم الفحص الميكروسكوبى ذو الضوء المستقطب لكل من المعادن الخفيفة والثقيلة لمكون الرمل، وكذا إنكسارات الأشعة السينية لمكونى السلت والطين للتعرف على مختلف المعادن الحاملة للمغذيات، بالإضافة إلى تحديد صورها المتبادلة والمرتبطة مع المادة العضوية، الكربونات، أكاسيد المنجنيز، أكاسيد الحديد الأمورفية والمتبلورة، الجزء المتبقى، لما لها من أهمية قاطعة فى التعرف على حالة خصوبة التربة . وقد إتضح أن معظم كميات الفوسفور مرتبطة مع مكون المادة العضوية والكربونات بحد أقصى وصل حوالى ٢٠،٢٦٪ من الصور الكلية للفوسفور المرتبطة فى كل من الأراضى النهرية الرسوبية والصحراوية ذات الطبيعة الجيرية على التوالى، كما كانت أعلى القيم للجزء المرتبط من البوتاسيوم مع المادة العضوية هى حوالى ١٥٪ من الصورالكلية للبوتاسيوم المرتبط فى الأراضى البحيرية الحديثة. أما بالنسبة لكل من الكالسيوم والماغنسيوم فكانا أكثر إرتباطا بمكون الكربونات - خاصة فى الأراضى الصحراوية ذات الطبيعة الجيرية – بقيم مرتفعة أكثر من ٣٩، ٦٨٪ من الصور الكلية المرتبطة لكلاهما على التوالى. كما سجل الكبريت المرتبط بمكون المادة العضوية قيما مرتفعة نسبيا (٣٠-٣١٪ من الصور الكلية للكبريت المرتبط) فى الرسوبيات النهرية والبحيرية . وتوضح النتائج أن كمية محسوسة من المغذيات الصغرى المرتبطة كانت أكثر وضوحا فى

الأراضى المتكونة من الرسوبيات النهرية، حيث كان الحديد اكثر إرتباطا بأكاسيد الحديد الأمورفية والمتبلورة (حوالى ٢٤، ٤٠٪ على التوالى)، المنجنيز اكثر إرتباطا بأكاسيد المنجنيز والحديد (٣٠.٧٥،٢٣.٥٤٪ على التوالى)، والزنك اكثر إرتباطا بأكاسيد الحديد الأمورفية والمتبلورة (حوالى ٢٢، ٣٧٪ على التوالى)، بينما كان النحاس فى الرسوبيات البحيرية اكثر إرتباطا بأكاسيد الحديد الأمورفية والمتبلورة (حوالى ٢٠، ٢٢٪ على التوالى). كما تبين أن الكمية الكلية من الفوسفور والبوتاسيوم فى رسوبيات الأراضى تحت الدراسة يمكن ترتيبها تنازليا فيما يلى:

Aeolian < carbonatic desert formation < recent lacustrine < Nile alluvium.

وبالنسبة للكالسيوم والماغنسيوم والكبريت:

Aeolian < Nile alluvium < recent lacustrine or carbonatic desert formation.

أما المحتوى الكلى من المغذيات الصغرى (Fe, Mn, Zn and Cu) كان أكثر إختلافا فى رسوبيات الأراضى تحت الدراسة، حيث سجلت أعلى وأقل القيم فى كل من الأراضى الرسوبية النهرية والصحراوية ذات الطبيعة السليكاتية على التوالى، ويرجع إرتفاع قيمها إلى زيادة محتوى التربة من المادة العضوية، أكاسيد الحديد الأمورفية والمتبلورة ومعادن الطين. كما وأن الجزء الميسر من المغذيات المدروسة كان تقريبا مشابها لإتجاه المحتوى الكلىن فيما عدا الفوسفور والعناصر الصغرى فى الرسوبيات الصحراوية، ويرجع ذلك أساسا إلى إنخفاض المحتوى من المادة العضوية، المعادن الحاملة للعناصر، القدرة على الإحتفاظ أو الإدمصاص فى الرسوبيات الرملية السليكاتية، بالإضافة إلى ترسيبها مع $CaCO_3$ فى الرسوبيات الجيرية.

وتشير النتائج المتحصل عليها من التحليل الإحصائى، باستخدام برنامج (1997) SPSS، ومعامل الإرتباط البسيط إلى أن هناك علاقة موجبة ومعنوية بين كل من المغذيات تحت الدراسة وبعض المعادن الحاملة لها فى المجموعات الحجمية المختلفة فى التربة ، ومن ثم فقد تحقق الهدف النهائى من هذه الدراسة عن طريق إقتراح علاقة بسيطة بين المصادر المعدنية لبعض المغذيات الضرورية للنبات والنسب المئوية لمساهمتها بالإمداد بتلك المغذيات المنطلقة فى رسوبيات الأراضى تحت الدراسة.