Egyptian Journal of Agricultural Research

Soils Water and Environment

ORIGINAL ARTICLE Egypt. J. Agric. Res., (2020), 98 (4), 559-568

Essential nature of pedogenic concentrations for differentiation soil taxa

I. F. Rashad

Soils Water and Environment Research Institute, Agricultural Research Center, Giza, Egypt

(Manuscript received 21 Jun 2020)

ABSTRACT

The current study was undertaken to elucidate and give more attention about the nature of pedogenic concentrations and their relation for differentiated soil taxonomic units. Fourteen soil profiles were selected to represent some soils developed under the environmental conditions of some common geomorphic units in Egypt. The abundance and nature of pedogenic calcium carbonate, gypsum, soluble salts and gley phenomena were morphologically described and discussed geomorphological. These pedogenic features are the most factors used for the subdivisions of soil master horizons designations.

The selected 14 soil profiles were classified to 14 soil families differentiated under 12 subgroups belonging to 3 suborders of Aridisols and 2 suborders of Vertisols. The diagnostic of both soil horizons and characteristics related to soil concentrations are the most common factors for identified the obtained soil taxa. The soil series differentia within families are the most important level related to agriculture land use. The narrowly total concentrations content, depth and thickness of diagnostic horizons are the commonly criteria used for soil series. Relevant to potential uses of soils, some additional properties such as fractionation of total $CaCo_3$ and active fraction, size, shape, color and hardness of secondary crystalline of different concentrations should be taken into account to differentiate between soil series or for phase distinctions.

Keywords: Soil taxa, pedogenic concentrations, differentiation

INTRODUCTION

The basis of pedology in soil science is that soil is no longer considered as an inert material that reflects only the composition of the underlying rock or parent material, but that it is formed and developed as a result of the effect of the active environmental factors of climate, vegetation and time on the mineral materials.

The earliest theoretical speculations on desert soil formation mentioned that moisture was so limited that chemical weathering should not occur. By mid– 20th century, widespread occurrence of strongly differentiated apparently pedogenic soils had been demonstrated for deserts (Wilding et al., 1983). The processes forming those soils are thought quite similar to those acting on humid land soils except for the effects of limited leaching and recurrent dissociation (Buol, 1965). The water that circulates in the soil pores carries with it certain entities either in solution or precipitation of the suspended materials and is responsible for either general downward movement. A great amount of the materials thus mobilized and can be removed completely from the soil profile. In contrast, as in arid and semiarid regions, another part of the mobilized material is redistributed and deposited at the lower level in the profile as alluvial horizons. The upward movement of material may occur, but more rarely as particular circumstances are necessary. Also, hydromorphic soils are characterized by the reduction or localized segregation of iron, owing to the temporary or permanent waterlogging of the soil pores which causes a lack of oxygen over a long period (Duchaufour, 1982). Under such conditions, the accumulations of pedogenic concentrations as an evaporite layers are common features in some soils of Egypt. They may have one or more pedogenic horizons that formed in the present environments or more probably relicts from the former pluvial period (Rabie et al., 1993). These horizons may be the result of translocation and accumulation of soluble salt, gypsum and/or lime, as well as gley phenomena.

A soil survey always brings up a number of questions about the characteristics of soils, their properties and origin and about proper analysis method, which need further investigation could be undertaken. Concentrations of the materials as an important section of soil profile description including cutanic features, cementation and secondary nodules. The later items are described according to their abundance, kind, size, shape, hardness, nature and color (FAO, 2006). These pedogenic characteristics are mainly used for differentiated the soil taxonomic units developed in arid regions.

As soil classification provides integrated knowledge about the soil in relation with the environments and enables predictions of their behavior and response to anthropic intervention in its natural development. The current study was undertaken to elucidate and give more attention to the nature of pedogenic concentrations and their relation to differentiated soil taxa.

MATERIALS AND METHODS

Fourteen soil profiles were selected to represent some soils developed under the environmental conditions of some common geomorphic units in Egypt. The profiles were morphologically described (Table 1) according to the FAO guidelines (FAO, 2006). Representative soil samples were collected from the different profile layers for soil analyses.

According to USAD (2004), the fine earth (<2mm) soil samples were analyzed for particle size distribution by pipette method and the distribution of some chosen samples were carried out after removing calcium carbonate; soil reaction (PH) in the saturated soil paste and soil salinity as Electrical Conductivity (ECe) of the saturated soil extract; Cation Exchange Capacity (CEC) and Exchangeable Sodium Percent (ESP) using ammonium chloride solution of PH 8.5; $CaCo_3$% by using the Collin's Calcimeter; and gypsum content by precipitation with acetone (Table 2).

Soil taxonomic units and soil horizons designation were categorized and named (Table 3) according to the key to soil taxonomy USDA (2014) and FAO (1998).

Table 1. Morphological description of the selected soil profiles

Prof. No.	*Landform	Location	Soil description	Pedogenic features
1	Almost flat, lacustrine soils; 24m a.s.l., barren	El-Nubaria area, south of El-Naser canal	Brownish yellow loose loamy sand surface layer (0-20cm) over soft massive structure loamy sand up to 45 cm depth following by strong brown hard massive sandy clay loam	Few indurated lime nodules in the subsurface layer, many soft lime segregation and patches in the 45-80cm layer
2	As above; 21m a.s.l, cultivated	El-Nubaria area, Gianaclis plain	Yellowish brown clay loam surface layer (0-25cm) in weak blocky structure and hard consistence over very pale brown sandy clay loam up to 60cm following by massive silty clay loam in hard consistence	Many soft and different lime with many indurated lime nodules in the subsurface and subsoil
3	As above; 20m a.s.l, barren	El-Nubaria area, south of El-Naser canal	Yellowish brown sandy loam surface layer (0-15cm) over sandy clay loam in weak blocky structure up to45 cm depth following by strong brown loam in massive structure	Many soft lime segregations and common indurated nodules in the 15-45 layer, many soft and indurated lime nodules up to 80cm many soft whitish fine crystal gypsum dots (80-120cm)
4	Knoll slop, lacustrine soils; 41m a.s.l, barren	El-Nubaria area, Maryut	Brownish yellow slightly hard sandy clay loam surface layer (0-20cm) over very pale brown sandy clay loam in hard consistence up to 40 cm following by extremely hard lime layer	Common soft lime segregation and common indurated lime nodules up to 40 cm over indurated lime layer as boulder size blocks
5	Gently undulating old alluvial terraces, 100m a.s.l, barren	Ismalia Gov., south of Elsalhia project	Reddish yellow loose gravelly loamy sand surface layer (0-25cm) over very gravelly loamy sand in soft consistence up to 60cm following by loose very gravelly sand	Many soft and hard lime segregation and coating gravel in the 25-60cm layer
6	Low part of gent. Undulating old alluvial. Terraces, 40m a.s.l., barren	Western desert, north-east of Sadat city area	Strong brown soft loamy sand surface layer (0-15cm) over light brown gravelly loamy sand up to 40cm following by brownish yellow gravelly sand	Few soft lime segregations up to 40cm, common soft fine gypsum crystal in veins in the 15-40cm layer, common fine lime and gypsum coating gravel in the 40-90cm layer
7	Almost flat old alluvial terraces, 85m a.s.l., barren	Eastern desert, north-west of the 10th of Ramadan city	Brownish yellow soft loamy sand surface layer (0-20 cm) over yellow soft very gravelly sandy loam up to 60 cm following by reddish yellow loose gravelly sand	Few soft lime segregations and patches up to 60 cm, common gypsum dots and coating gravel

*a.s.l. above sea level

. **Table 1.** Cont.

Prof. No.	*Landform	Location	Soil description	Pedogenic features
8	Gent. Undulating bajada plain, 60m a.s.l., barren	Western desert, west of samalut, El-Menya Gov.	Yellowish brown loamy sand surface layer (0-30cm) over dark yellowish brown gravelly sandy clay loam in slightly hard consistence up to 70cm following by yellowish brown sand	Common fine gypsum crystals up to 70cm depth, few soft limes throughout the profile
9	Depressed fluvio-marine plain, 1m a.s.l., cultivated	Abou El-Matamir, El-Beheira Gov.	Grayish brown sticky clay in weak blocky structure surface layer (0-25cm) over light gray very sticky clay in moderate blocky structure, few to common broken shells, water table at 110cm depth	Many coarse soft lime segregations in brownish yellow color in the 25-85cm layer with gley phenomena
10	Terrasses Nile alluvial plain 18m a.s.l., old cultivated	Tamia, north east of El-Fayoum Gov.	Grayish brown sticky clay in moderate blocky structure surface layer (0-20cm) over gray very sticky clay in angular blocky structure following by dark grayish brown clay	Common soft lime segregation coating fine concreation in the subsurface layer, clear slickensides, at 20-60cm depth
11	Almost flat fluvio-marine marshes, < 1m a.s.l. recently cultivated	North-east of Nile Delta, El-Hasainiy a plain, Sharkia Gov.	Dark grayish brown to dark gray by depth, very sticky clay in angular blocky structure, water table at 90cm depth	Some surface brown salts, common mottles in the 20-45cm layer following by gley phenomena, clear slickensides (45-90cm)
12	Almost flat fluvio-marine marshes, < 1m a.s.l., reclaimed soil	Abou-Rayia area, north-east of Kafr El-Sheik Gov.	Very dark grayish brown throughout the profile, very sticky clay in angular blocky structure, water table at 100cm depth	Common grey mottles in the 20-70cm layer, clear sckensides in subsoil
13	Almost flat fluvio-marine marshes, 0.5 m a.s.l., barren	El-Tina plain, south of port Foad and east of Suez Canal	Gray sticky sandy clay loam in massive structure surface layer (0-30cm) over dark brown to very dark grayish brown depth, sticky sandy clay in weak blocky structure, water table at 100cm	Salt surface crust (4cm thick), fine salt crystals throughout the profile, common fine gypsum crystal dots in the surface layer
14	Almost flat marshy and dry sabkhas 1m a.s.l., barren	South of Elbardawil lake, North Sinai	Pale brown loose fine sand up to 80cm depth over gray sand up to 100cm following by massive sandy clay loam, water table 80cm depth	Thin hard surface salt crust, many salt accumulation (0-30cm), common fine dark color and hard gypsum crystals (50-80cm), gley phenomena in subsoil

*a.s.l. above sea level

RESULTS AND DISCUSSION

The investigated soils:

The differences in soils are closely associated with variation in its origin that influences the nature of soils, as well as the effect of man through agriculture land use. The selected soil profiles, which extensively mantled with Pliocene, Pleistocene and Holocene epochs, were taken from the north coastal plain as marine-Lacustrine soils (profiles 1, 2, 3 and 4), fluvio-marine plain soils (profile 9), fluvio-marine marshes (profiles 11, 12 and 13), and sabkhas (profile 14); the desert fringe on both sides of Nile Valley and Delta as old alluvial terraces (profiles 5, 6 and 7) and bajada (profile 8); and the terraced Nile alluvial plain border to the old alluvial plain (profile 10). The main morphological description of these profiles and soil samples analysis are shown in Tables 1 and 2, respectively.

The pedogenic concentrations:

Morphological, the presence of pedogenic lime, gypsum, soluble salts and gley phenomena were clearly observed in the studied soil profiles. According to the origin and environmental conditions, these features were found singly or in combination throughout soil profile layers in different abundance, shapes, sizes and colors. In the marine-lacustrine soils lime ($CaCO_3$) accumulations are the dominant pedogenic features. Considerable part of the total content of $CaCO_3$ that ranged from 12.9 to 75.5% (Table 2) were observed in the field as soft lime segregations (soft nodules) with diffuse form of fine particles as patches that caused more light color in the matrix of subsurface layer (profile 1). The soft nodules and diffuse form were associated with fine and medium size of indurated lime nodules (profiles 2 and 3), while the boulder size blocks of indurated subsoil lime layer as "calish" was identified in some physiographic positions (profile 4). Also, some soils of the fluvio-marine plain (profile 9) are characterized by high $CaCO_3$ content that clearly observed as coarse soft segregations and diffuse form in brownish yellow color of the gley greyish soil color matrix. The accumulation of $CaCO_3$ in the old alluvial terraces and bajada (profiles 5, 6, 7 and 8) were also identified but in relatively less amount if compared with the previous land types. It observed mainly in the field as soft and hard lime segregations in the soil ped voids and/or coating coarse fragments and some their interstices. However, the common powdery grayish color lime segregation, as thick coating of fine lime concretions were observed in the recent Nile alluvial terraces located near the old alluvial plain (profile 10). Calcite is the major authigenic deposits that formed from primary mineral dissolution by chemical weathering, calcium transport as the bicarbonates and deposition as calcite at about the common depth of wetting upon soil desiccation (Wilding et al., 1983). A number of works in Egypt among of them Harga et al. (1973), Abdel Kader et al. (1975), Abdou et al. (1984), Rabie et al. (1993) and Wahba (2003) indicated the accumulations of calcite by using microscopic investigations.

The pedogenic gypsum ($CaSO_4 – 2H_2O$) is mainly associated with lime and/or soluble salt accumulations. The soil with gypsum accumulation occurs when SO_4^{2-} is an important or the dominant soluble anion. Most of gypsiferous parent materials have formed from marine sedimentary rocks (Nelson et al. 1976). However, the authigenic gypsum of non-gravelly soils occurs as peculiarly whitish, powdery or crystalline, soft masses, or diffuse through a general depth zone of concentration, rather than occurring as carbonates do neatly delimited, continuous horizons, while in the gravelly materials, the gypsum may occur as pendants below pebbles (Wilding et al., 1983). In the investigated marine-lacustrine and old alluvial plains, the accumulation of gypsum was observed as whitish soft fine crystals segregated in dots and/or small veins. It is found in the subsurface layer of profiles 6 and 8 within or above lime. In some of the hydromorphic soils of fluvio-marine marshes (profile 13) and sabkhas (profile 14), the accumulation of gypsum was found as segregations of relatively dark color and more hard crystals in association with soluble salts accumulation and gley phenomena. The salt surface crust and subsurface fibrous salt crystals with gray soil matrix were also clearly observed. In addition, the shrinking – swelling clay soils under aquic condition represented by profiles 11 and 12 indicate clear intersecting slickensides but no sign of clay illuviation as cutanic features were observed. These soils are characterized by distinct mottles and gley subsoils with high exchangeable sodium percent (Table 2).

In addition, the above-mentioned visible concentrations represent the important features used for soil horizon designations. The master horizons and their subdivisions of the investigated soil profiles were attached in Table 2. The obtained contiguous horizon and layer symbols indicate the result of pedogenic processes. The downward and/or upward illuvial concentrations of carbonates, gypsum and soluble salt beside gleying and slickensides phenomena were taken for the designating horizons and layers (USDA, 2014).

Soil Taxonomic units:

The selected 14 soil profiles were categorized to the family level according to the key to soil taxonomy (USDA, 2014), and to the subdivisions of the reference soil groups (FAO, 1998). The 14 soil profiles named to 14 soil families differentiated under 12 subgroups that belong to 3 suborders of *Aridisols* namely *Calcids*, *Gypsids* and *Salids*, beside 2 suborders of *Vertisols* namely *Torrerts* and *Aquerts*. The obtained soil taxonomic units and their corresponding (FAO, 1998) system were listed in Table 3. The diagnostic of both soil horizons and characteristics related to soil concentrations are the common factors for identification to subgroups of the American system and to the subdivisions of soil groups in (FAO, 1998) system.

The diagnostic calcic horizon:

The different kinds of visible lime accumulations in soil profiles 1, 2, 3, 4, 5, 6, 9 and 10 are within the concept of identifiable secondary carbonates required for calcic and petro calcic horizons. Gile et al. (1965) and Gile (1966) indicated four sequences stages (I, II, III and IV) for the pedogenic carbonates accumulations in *Aridisols.* Generally, the stages II and III are Calcic horizons while stage IV considered petro calcic horizon. From 15 to 40 percent authigenic calcium carbonate content is required to form a k-fabric, but petro calcic horizons commonly have much greater carbonate contents (Gile, 1961). The stage II was identified in soil profiles 1, 5, 6, 9 and 10. Stage III is characterized by many commonly cemented or indurated carbonate nodules as durinodes in a non-brittle matrix (profiles 2 and 3) and could be classified as *Petronodic* subgroups. The irregular shape and color boundaries of these nodules indicated the formation in situe rather than transported by wind or water (Wider and Yealon, 1974, and Abdou et al., 1984). The k-fabric in stage IV is achieved be deposition of indurated layers on top of the plugged stage III (profile 4). For the family level, the more high contents of $CaCO_3$ accumulation were used as *carbonatic* mineralogy class in profiles 1, 2 and 4, while the durinods could be considered as coarse fragments and the skeletal particle size class used for the family name of profile 2. The above-mentioned different forms of pedogenic lime and its total content are of very great importance but are not the only effective parameter in the soil. The distribution of total $CaCO_3$ among the particle size fractions and active $CaCO_3$ are also very important. The data showed in Table 4 indicate that the majority of calcium carbonate content in the calcic horizons of some selected soil samples is within the fine fraction. The predominance of clay and silt size carbonate (active $CaCO_3$) is indicative of pedogenic secondary carbonates. It can be attributed to the transportation and sedimentation processes in aqueous media (Negm et al., 1990). In the clayey textured soils, the $CaCO_3$ in clay fraction recorded 7.6 and 14.3 % representing 45.2 and 37.2 % of the total $CaCO_3$ in profiles 10 and 9 respectively. The silty clay loam and sandy clay loam samples indicate 23.2 and 14.9 % $CaCO_3$ in clay fraction which represent 38.3 and 31.2% of the total carbonates in profiles 2 and 1 respectively. In the coarse textured soil, the values are 9.1 and 3.9% representing 34.9 and 25.1% of the total in profiles 5 and 6 respectively. The presence of $CaCO_3$ in clay fraction in the coarse textured soils can have a favorable effect on its suitability by irrigation. In contrast, the loamy sand surface sample in profile 1 indicates only 1.8 % of the total $CaCO_3$ (24.2 %). The main origin of these layers are the oolitic sand minerals which transported by wind causing an increase in the total $CaCO_3$ content but not in the active fraction (Rabie et al., 1993). However, the relatively high solubility of soil carbonate is due to the portion of very small crystallite size, and when small (metastable) and large crystals (more stable) coexist in a saturated solution, the larger crystal have a lower free energy than smaller ones (Wilding et al., 1983). Therefore, the distribution of total $CaCO_3$ and the active fraction could be taken into account in soil series level within families.

Table 2. Laboratory determinations of the investigated soil profile samples

Prof. No.	Horizons or Layers		PH	EC ds/m	CEC cmol/kg	ESP	CaCO3 %	Gypsum %	Coarse fragm. %	Partical size distribution%				Texture class*
	Depth cm	Symbole								C.Sand	F.sand	Silty	Clay	
1	0-25	AC	7.8	0.58	4.10	5.9	23.5	0.19	0.0	54.7	31.8	7.5	6.0	LS
	20-45	Ck	7.4	4.33	6.21	8.4	26.4	0.40	3.0	50.7	37.6	3.3	8.4	LS
	45-80	Bk	7.5	14.6	13.8	7.1	48.5	0.60	1.0	20.6	29.3	23.8	26.3	SCL
	80-120	C	7.5	14.4	16.4	10.8	33.1	0.37	4.0	18.0	30.7	17.3	34.0	SCL
2	0-25	ACp	7.4	7.85	17.0	9.18	36.8	1.50	0.0	20.0	22.3	20.3	37.4	CL
	25-60	Bk	7.9	4.45	14.5	9.03	46.6	0.74	50.0	16.9	33.4	20.4	29.3	SCL
	60-100	Bkk	8.0	4.78	15.1	7.88	65.1	0.73	35.0	7.60	10.7	48.2	33.5	SICL
3	0-15	AC	7.6	7.2	9.0	6.6	31.5	0.30	4.0	25.4	47.9	14.4	12.3	SL
	15-45	Bk1	7.6	8.8	14.0	7.1	40.2	0.20	15.0	29.6	33.7	15.1	21.6	SCL
	45-80	Bk2	7.6	11.5	13.0	7.4	30.1	1.90	40.0	19.2	26.1	32.5	22.2	L
	80-120	Byk	7.7	13.6	14.0	7.3	26.3	15.5	3.0	16.2	23.1	35.3	25.4	L
4	0-20	AC	7.6	24.1	17.4	8.2	12.9	0.90	6.0	26.6	36.8	14.5	22.1	SCL
	20-40	Bk	7.5	25.6	15.1	9.6	14.2	1.01	20.0	20.1	40.5	13.8	25.6	SCL
	40-70	Bkqm	7.4	17.5	11.3	7.5	75.5	0.81	-	15.5	35.9	18.4	30.2	SCL
5	0-25	ACk	8.01	11.4	6.11	7.6	9.3	0.39	28.0	27.9	54.8	9.13	8.17	LS
	25-60	Bk1	8.2	22.0	5.65	11.4	27.2	0.32	45.0	34.6	46.6	8.85	9.95	LS
	60-100	Bk2	8.3	18.9	4.91	10.5	19.3	0.15	40.0	40.4	48.1	6.41	5.19	S
6	0-15	ACk	7.7	10.5	8.3	12.7	7.5	2.11	3.0	25.5	55.8	12.3	6.4	LS
	15-40	Byk	7.6	32.6	7.1	11.2	9.8	13.2	22.0	36.2	46.1	12.6	5.1	LS
	40-90	Bky	7.9	20.8	6.2	10.3	16.9	7.3	20.0	44.8	43.8	7.1	4.3	S
	90-150	Cy	8.1	8.11	5.1	7.4	6.2	1.5	4.0	52.6	41.3	3.7	2.4	S
7	0-20	ACk	7.4	52.0	11.6	13.1	4.5	0.32	10.0	32.7	48.5	7.1	11.7	LS
	20-60	Bk	7.6	60.0	12.2	14.2	8.2	1.8	50.0	37.1	36.6	14.6	11.7	SL
	60-100	Byk	7.5	43.0	6.3	10.5	3.4	9.2	20.0	72.8	19.8	5.66	2.34	S
8	0-30	ABy	7.4	11.0	5.8	12.3	6.9	9.3	14.0	44.8	35.1	13.0	7.1	LS
	30-70	Byk	7.6	80.1	19.5	12.2	7.2	11.2	15.0	24.5	30.1	15.8	29.6	SCL
	70-110	Bk	7.8	65.2	4.8	8.3	8.9	5.4	8.0	35.2	52.6	7.1	5.1	S
9	0-25	Apk	7.9	5.2	43.6	9.6	22.3	1.2	0.0	7.3	18.0	11.4	63.3	C
	25-55	Bkg1	8.0	2.7	40.2	6.8	34.7	0.8	2.0	15.0	17.7	11.7	55.6	C
	55-85	Bkg2	8.0	5.1	38.7	7.4	36.6	0.7	12.0	20.1	16.6	11.5	51.8	C
	85-110	Bkg3	8.0	3.5	41.2	6.2	20.2	0.4	4.0	9.8	31.6	11.0	47.6	C
10	0-20	Ap	8.1	2.2	49.6	6.6	12.1	1.4	0.0	8.4	15.1	26.6	49.9	C
	20-60	Bkss	8.2	2.6	46.3	7.8	18.6	3.1	1.0	7.6	14.2	22.4	55.8	C
	60-100	Bkg	8.2	1.5	44.7	10.1	13.2	2.5	0.0	4.2	16.2	23.1	56.5	C
11	0-20	Ap	7.6	11.2	49.0	20.1	0.27	0.0	0.0	3.5	13.0	21.0	62.5	C
	20-45	Cz	7.7	14.1	48.0	25.9	5.6	0.0	0.0	1.2	3.9	37.2	57.7	C
	45-90	Cssg	7.7	20.2	51.3	30.9	0.4	0.0	0.0	0.3	0.7	35.5	63.5	C
12	0-20	Ap	8.3	4.1	45.0	12.2	1.4	0.2	0.0	0.5	20.6	20.1	58.8	C
	20-70	Cg	8.5	7.8	59.0	28.4	0.6	0.1	0.0	0.6	18.7	15.0	65.7	C
	70-100	Cssg	8.4	5.7	44.5	22.4	1.9	0.1	0.0	0.5	22.8	14.5	62.2	C
13	0-30	AByz	7.9	187	41.9	8.4	0.35	8.6	0.0	11.4	46.9	17.2	24.5	SCL
	30-80	Cz1	7.8	165	42.7	15.9	0.02	1.42	0.0	3.8	43.5	16.8	35.9	SC
	80-100	Cz2	8.1	157	52.9	13.4	3.9	1.9	0.0	2.4	47.1	11.1	38.4	SC
14	0-30	Acz	7.7	94.6	4.1	4.88	0.8	2.71	0.0	0.79	97.2	0.02	1.99	S
	30-50	Cz	8.04	93.7	4.05	4.94	0.95	3.44	0.0	1.08	97.1	0.10	1.75	S
	50-80	Byz	8.25	86.4	3.11	8.68	1.56	13.3	0.0	2.30	96.2	0.11	1.39	S

* S sand, LS loamy sand, SL sandy loam, L loam, SCL sand clay loam, CL clay loam, SC sandy clay, C clay

The diagnostic gypsic horizon:

The morphological visible gypsum accumulation and gypsum content (Tables 1 and 2) in soil profiles 3, 6, 7, 8, 13 and 14 are within the concept of diagnostic gypsic horizon which has accumulated or been transformed to a significant extent. The horizon used to name the suborder *Gypsids*(USDA 2014) and the great group *Gypsisols* (FAO, 1998) in profiles 3, 6, 7 and 8, also to name the *Gypsic* subgroup in profiles 13 and 14. For the family level, the limits of gypsic mineralogy class are not identified in the investigated soil profiles. The obtained soil taxonomic units are dependent mainly on the gypsum content rather than its kind and hardness. The gypsum may be found in the form of pseudo mycelia, as coarse-sized crystals (individualized as nests, beard or coating, or as elongated grouping of fibrous crystals) or as compact powdery accumulation. The later form gives the gypsic horizon a massive structure and a sandy texture. The distinction between compact powdery accumulations and the others is important in terms of soil potentiality (FAO, 1998). The gypsum forms in the investigated soils are found as segregation of dots, veins, or elongated crystals, but in different color, size and hardness. These forms should be considered as differentiae soil series within families or considered as a basis for phase distinctions. On the other hand, it is well known that a small amount of gypsum is favorable for crop growth as it affects soil physical properties. It improves the structure and prevents sodium saturation especially in the clayey textured soils. This is the case of profile 13 when put under reclamation if compared with the lowest gypsum content in profile 12.

Table 3. Soil taxonomic units of the investigated soil profiles

Physiographic Units	Prof. No.	Soil Taxonomic Unites
Lacustrine Plain	1	**Sandy over loamy, mixed over carbonatic, thermic, Typic Haplocalcids* ***Haplic Calcisols*
	2	**Loamy-skeletal, carbonatic, thermic, Petronodic Haplocalcids* ***Skeletic-Hyperclacic Calcisols*
	3	**Fine-loamy, Mixed, thermic Petronodic Calcigypsids* ***Calcic-Skeletic Gypsisols*
	4	**Fine-loamy, Carbonatic, thermic, shallow Typic Petrocalcids* ***Petric-Hypercalcic Calcisols*
Terraced old alluvial plain	5	**Sandy-skeletal, mixed, hyperthermic Typic Haplocalcids* ***Skeletic-Haplic Calcisols*
	6	**Sandy, mixed, thermic Typic Calcigypsids* ***Calcic-Haplic Gypsisols*
	7	**Sandy, mixed, hyperthermic Typic Haplocalcids* ***Haplic Gypsisols*
Bajada plain	8	**Fine-Loamy over sandy, mixed, hyperthermic Typic Haplocalcids* *** Haplic Gypsisols*
Fluvio-marine plain	9	**Fine, mixed, thermic Aquic Haplocalcids* ***Calcic Gleysols*
Terraced Nile alluvial plain	10	**Fine, smectitic , hyperthermic Typic Clacitorrerts* ***Calcic Vertisols*
Fluvio-marine marches	11	**Very-fine, smectitic, thermic Halic Endoaquerts* ***Salic-pellic Vertisols*
	12	**Very-fine, smectitic, thermic Sodic Endoaquerts* ***Salic-Hyposodic Vertisols*
	13	**Fine, mixed, thermic Gypsic Haplosalids* ***Gypsic Solonchaks*
Sabkhas	14	**Sandy, siliceous, thermic Gypsic Aquisalids* ***Gleyic-Gypsic Solonchaks*

* USDA (2014)
** FAO (1998)

Table 4. Distribution of total carbonate contents in the different fractions of some selected soil samples

Profile No.	Layer depth (cm)	Particle size fractions					Texture of fine earth	Total CaCO3% in fraction
			Coarse sand > 200M	Fine sand 200-63M	Silt 63-2M	Clay <2M		
1	0-20	A	57.7	31.8	7.50	6.00	LS	-
		B	43.1	20.9	6.23	5.57	-	-
		C	11.6	10.9	1.27	0.43	-	24.2
		D	47.9	45.1	5.20	1.80	-	-
	45-80	A	20.6	29.3	23.8	26.3	SCL	-
		B	13.9	21.9	4.9	11.4	-	-
		C	6.7	7.4	18.9	14.9	-	47.9
		D	13.9	15.4	39.5	31.2	-	-
2	60-100	A	7.60	10.7	48.2	33.5	SiCL	-
		B	4.71	1.39	23.1	10.3	-	-
		C	2.89	9.31	25.1	23.2	-	60.5
		D	4.8	15.4	41.5	38.3	-	-
5	25-60	A	34.6	46.6	8.85	9.95	LS	-
		B	32.1	39.8	1.13	0.85	-	-
		C	2.5	6.8	7.72	9.1	-	26.1
		D	9.5	26.1	29.5	34.9	-	-
6	40-90	A	44.8	43.8	7.10	4.30	S	-
		B	42.9	40.5	0.70	0.40	-	-
		C	1.90	3.3	6.40	3.90	-	15.5
		D	12.3	21.3	41.3	25.1	-	-
9	55-85	A	20.1	16.6	11.5	51.8	C	-
		B	15.8	7.4	0.90	37.5	-	-
		C	4.30	9.2	10.6	14.3	-	38.4
		D	11.3	23.9	27.6	37.2	-	-
10	20-60	A	7.60	14.2	22.4	55.8	C	-
		B	5.60	11.5	17.9	48.2	-	-
		C	2.00	2.7	4.5	7.6	-	24.2
		D	11.9	16.1	26.8	45.2	-	-

A: with CaCO3 C: CaCO3 in fractions
B: without CaCO3 D: CaCO3% of total

The salic horizon and aquic conditions:

Salic horizon occurs only in a few in extensive *Aridisols*. In soil profiles 13 and 14 representing the fluvio-marine and sabkhas, the identified diagnostic salic horizon named the *Salids* suborder (USDA, 2014) and *Solonchaks* great group (FAO,1998). The salic horizon in profile 14 is formed under soil aquic conditions and named as *Aquisalids* or *Gleyic Solonchaks*, while the *Haplosalids* in profile 13 represent salic horizon formed when the moisture control section is dry in some or all parts at some time during normal years (USDA, 2014). Some of the upland barren soils may have salt accumulation reaches to the limits of salic horizon as shown in the subsurface layer of profile 8. Soils like this are not classified as salids and their salt accumulation reflect some old environment condition related to the former pluvial period. Therefore, the soil moisture regimes including aquic condition in the low laying soils are closely related to salt accumulation as salic horizon.

The hydromorphic soils are characterized by having special environment under which water controls their developing processes and gives their profiles particular characters such as gleying phenomena or mottling. The soils with aquic conditions are those that currently undergo continuous or periodic saturation and reduction. These diagnostic characteristics were used for naming the *Aquert* suborder of *Vertisols* (profiles 11 and 12), the *Aquisalids* great group (profile 14), and the aquic subgroup of *Haplocacids* (profile 9). The corresponding taxonomic units in the FAO system are *Pellic Vertisols*, *Gleyic Solonchaks* and *Gleysols*, respectively. Also, the *Aquic* conditions indicate the *Halic* (profile 11) and *Sodic* (profile 12) subgroups that give more attention about the problems of heavy textured soils.

The diagnostic of both soil horizons and characteristics related to soil concentrations are the most commonly factors for identified all classification categories from order to family level. Soil series is the more important level related to land use. The criteria most commonly used for differentiae soil series within a family are the more narrowly total concentrations content, depth and thickness of diagnostic horizons. Some important properties that also relevant to potential uses of soils such as fractionation of total $CaCO_3$and active fraction; size, shape, color and hardness of secondary crystalline of different concentrations, should be taken into account to differential soil series or for phase distinctions.

In conclusion, the nature of pedogenic concentrations could be descried carefully according to the guidelines of reference profile description. Also, the soil-forming (pedogenic) processes indicate its distinctive properties; therefore, the description of landform in geomorphological terms is important.

REFERENCES

Abdel-Kader, F. H., I. M. Gewaifel, M. N. Hassan and E. M. El-Zahaby 1975. A study ofcalcium carbonate in a toposequence at Bourg El Arab area, Egypt. Egypt. J. Soil Sci., 15, No.1-, 1-10.

Abdou, F. M., F. S. Hanna, F. H. Rabei, A. M. El Araby, S. I. and Abdel Rahman. 1984.

Formation of Calcium carbonate in some calcareous soil. Egypt. J. Soil Sci. 24, 145.

Buol, S. W. 1965. Present soil-forming factors and processes in arid and semi-arid regions. Soil Sci, 99:45-49.

Duchaufour, P. 1982. Pedology: Pedogenesis and classification. English edition by George

Allen & Unwin (publishers) Ltd, 1982.

FAO, 1998. World Reference Base for Soil Resources. World Soil Resources Reports 84, FAO, Rome.

FAO, 2006. Guidelines for soil description, fourth edition, FAO, Rome, ISBN 92-5-105521-10.

Gile, L. H. 1961. A classification of Ca horizons in soils of dessert regions, Dona Ana County, New Mexico. Soil Sci. Am. J., 25:52-61.

Gile, L. H., F. F. Peterson and R. B. Grossman 1965. The K horizon: A master horizon ofcarbonate accumulation – Soil Sci. 99:74-82.

Gile, L. H. 1966. Morphological and genetic sequences of carbonate accumulation in desert soils. Soil Sci., 101:347-360.

Harga, A. A., F. H. Rabie and M. A. Abd El-Salam, 1973. Studies of the soils of the coastallittoral of Egypt “A.R.E”. Egypt. J. Soil Sci. 13, No.2, 191-202.

Negm, M. A., N. E. Fanous and M. L. Mekhaiel, 1990. Some correlation between physical and chemical properties of Maryut desert soil. Egypt. J. Soil Sci. 30:91.

Nelson, R. E., P. S. Derr, L. C. Klameth, and W. D. Nettleton, 1976. Occurrence and measurement of gypsum in soils. Agron-Abstr., 1976. Annual Meetings of Am. Soc. Agronomy. P., 164.

Rabie, F. H., M. Y. Khadr, M. Z. Salem and M. A. Barakat (1993). A comparative micro morphological study on two great soil groups of agriculture land in Egypt. Egypt. J. Appl. Sci. 8, 628.

USDA, 2004. Soil Survey Laboratory Methods Manual. Soil Survey Investigation Report, No.42,

Version 4 November, Washington, USA.

USDA, 2014. Keys to Soil Taxonomy. 12^{th} Edition, USDA.

Wahba, M. M. 2003. Microfeatures and Distribution of Calcium Carbonate in Some Calcareous Soils of Egypt. Egypt. J. Soil Sci. 43, No.1:109-124.

Wider, M. and D. H. Yaalon, 1974. Effect of matrix composition on carbonate nodulecrystallization. Geoderma. 11, 95.

Wilding, L. P., N. E. Smeck and G. F. Hall, 1983. Pedogenesis and Soil Taxonomy. II. The soil Order Elsevier Science Publishers B.V., Amsterdam – Printed in the Netherlands.

ماهية التركيزات البيدولوجية فى تمييز وحدات تصنيف التربة

إبراهيم فوزى رشاد
معهد بحوث الأراضى و المياه و البيئة – مركز البحوث الزراعية – الجيزة ، مصر

إجريت هذه الدراسة لتوضيح و إعطاء مزيد من الاهتمام حول طبيعة التركيزات البيدولوجية و علاقتها فتمييز وحدات تصنيف التربة. لذلك تم إختيار أربعة عشر قطاع تربة لتمثيل بعض الأراضى التى تكونت تحت الظروف البيئية لبعض الوحدات الجيومورفولوجية الشائعة فى مصر.

و قد تم الوصف المورفولوجى الحقلى لمدى إنتشار و طبيعة التكوينات البيدولوجية الثانوية لكربونات الكالسيوم و الجبس و الأملاح الذائبة و ظواهر سوء الصرف من التبقع و الاختزال و نوقشت تلك العمليات جيومورفولوجيا، و دورها كعامل اساسى فى تمييز و تحديد آفاق و طبقات القطاع الأرضى.

و قطاعات التربة ال 14 تم تصنيفها إلى 14 عائلة تحت 12 من تحت المجموعات المنتمية ل 3 وحدات من تحت الرتب لاراضى *Aridisols* و إلى 2 من تحت الرتب لأراضى *Vertisols* ، و كانت الآفاق و الصفات التشخيصية ذات العلاقة بالتركيزات الثانوية للتربة الدور الاكثر شيوعا فى التعرف على الوحدات التصنيفية المتحصل عليها. و المعايير الاكثر إستخداما فى تميز و تفريق سلاسل التربة (Soil Series) تحت العائلات – و التى تعتبر ذات العلاقة المباشرة فى استخدام الارض زراعيا – تتمثل فى المدى المتقارب للكميات الكلية لتلك التركيزات و عمق و سمك الآفاق التشخيصية المتكونة منها، الا ان هناك صفات آخرى يجب عدم إغفالها و الاهتمام بأخذها فى الاعتبار مثل توزيع كربونات الكالسيوم بين الاحجام المختلفة للحبيبات و الكربونات النشطة، و كذلك حجم و شكل و لون و مدى صلابة التكوينات الثانوية المختلفة.

الكلمات المفتاحية: أصناف التربة، التركيزات البيدولوجية، التفريق