INFLUENCE OF THE PHYSIOGRAPHY LOCATION ON CHARACTERISTICS OF THE SEDIMENTARY PLAIN SOILS IN AL-RIFAI DISTRICT, DHI QAR PROVINCE

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ABSTRACT

The study was conducted in Al-Rifai district, Dhi Qar province, which located between two latitude (29"44¯31° and 50" 44¯31°) and two longitude line (25" 06¯46° and 27"07¯46°) for the purpose of identifying and comparing spatial Variability in the properties of morphological and physiochemical soil within different physiologic units in the lower sedimentary plain in southern Iraq. The soil samples were collected from three pedons represented by the traces of the river, river banks and river basin in three locations parallel to Al-Gharaf River which located within Al-Rifai district, Dhi Qar province during the period from November 2015 to April 2016. The results of the physical analyzes showed that the predominant textures were sandy loam and loam, with a percentage of 33.34% for each of them, The general average for apparent density values for the pedons (1, 2, 3) amounted to (1.50, 1.48, 1.43 µg.m-3), respectively. The saturated Hydraulic Conductivity of all the pedons was classified on the basis of their general averages to the medium velocity class according to an assessment [20]. The results of the chemical analysis showed that the soil of the first pedon recorded the highest content of the organic matter amounted to (6.43 $g.kg^{-1}$) followed by the second pedon amounted to (4.08 $g.kg^{-1}$) while the soil of the third pedon recorded the lowest content amounted to (2.65 $g.kg^{-1}$), all locations showed high content of calcium carbonate, with an average of (219 $g.kg^{-1}$) within a range of (262-168 $g.kg^{-1}$). The results showed that the lowest Coefficient of Variance recorded for the traits of the pH, apparent density, porosity, and calcium carbonate levels amounted to (2.25, 6.04, 7.16, 12.41%), respectively, indicating a slight Covariance and state of homogeneous, while there were medium Covariance and state of heterogeneous for the traits represented by the sand, silt, clay, the salinity, and the Saturated Hydraulic Conductivity, where the Coefficient of Variance for these traits amounted to (31.39, 34.24, 35.30, 47.06, 54.30%), respectively. The results of the field and laboratory studies showed that the soil of these locations belongs to the subgroup (Typic Torrifluvents).

Keywords: Morphology, Texture, Pedon, Sedimentary plain.

تأثير الموقع الفيزيوغرافي على خصائص تربة السهل الفيضي في منطقة الرفاعي / محافظة ذي قار

طالب صبر حريجة حسين خليفة جليب رياض شاكر بديح بتول هاتف كاظم

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الملخص

نفذت الدراسة في منطقة الرفاعي / محافظة ذي قاربين دائرتي عرض29"44¯31 ° و50"44¯31 ° وخطي طول 25"06¯46 ° و27"07¯46 ° لغرض التعرف ومقارنة التغاير المكاني في خصائص التربة المورفولوجية و الفيزيوكيمياوية ضمن وحدات فيزيوغرافية مختلفة في منطقة السهل الرسوبي الأسفل في جنوب العراق ، جمعت نماذج التربة من ثلاث بيدونات ممثلة لترب أكتاف النهر وضفاف النهر وحوض النهر في ثلاثة مواقع موازية لنهر الغراف تقع ضمن منطقة الرفاعي في محافظة ذي قار، خلال المدة من شهر تشرين

ISSN 2072-3875

الثاني 2015 ولغاية شهر نيسان 2016. بينت نتائج التحليلات الفيزيائية إن النسجة السائدة كانت المزيجة الرملية Sandy loam, SL والمزيجة loam, L وبنسبة 33.34 % لكل منهما، والمتوسط العام لقيم الكثافة الظاهرية للبيدونات 1 و2 و 3 بلغ 1.50 و1.48 و1.43 ميكاغرام م$^{-3}$ على التوالي ، وصنفت الأيصالية المائية المشبعة لجميع البيدونات على أساس معدلاتها العامة إلى صنف متوسط السرعة وفق تقييم [20] ، أما نتائج التحليلات الكيميائية فقد بين إن تربة البيدون الأول سجلت أعلى محتوى للمادة العضوية بلغ 6.43 غم كغم$^{-1}$ يليها البيدون الثاني 4.08 غم كغم$^{-1}$ في حين سجلت تربة البيدون الثالث أدنى محتوى بلغ 2.65 غم كغم$^{-1}$ ،أظهرت جميع المواقع محتوى عالي من كربونات الكالسيوم بمعدل 219 غم كغم$^{-1}$ ضمن مدى تراوح بين 168—262 غم كغم$^{-1}$ بينت النتائج إن أدنى معامل اختلاف سجل لصفات تفاعل التربة والكثافة الظاهرية والمسامية و كربونات الكالسيوم بواقع 2.25 و 6.04 و 7.16 و 12.41 % وعلى التوالي مما يشير إلى تغاير قليل وحالة من التجانس homogeneous في حين كان هنالك تغاير متوسط وحالة من عدم التجانس heterogeneous للصفات المتمثلة بالرمل والطين والغرين والملوحة والايصالية المائية المشبعة بدلالة معامل الاختلاف المسجل لهذه الصفات والبالغ 31.39 و 34.24 و 35.30 و 47.06 و 54.30 % على التوالي ،وبينت نتائج الدراسات الحقلية والمختبرية إن ترب هذه المواقع تنتمي إلى تحت المجموعة Typic Torrifluvents.

الكلمات المفتاحية: مورفولوجيا، نسجه، بيدون، سهل رسوبي.

1. INTRODUCTION

Sedimentary soil is generally formed from the sedimentation of rivers and freshwater lakes and has weakly formed Entities. Most of its properties are coming from the mother material and are characterized by the presence of the Stratification phenomenon and its texture is related to the velocity of the water deposition for alluvium and is characterized by very deep [1]. The geological formation of the sedimentary plain soil in southern Iraq is represented by the deposits that belong to the Miocene Late, which their thickness amounts to more than 200 m, it is found under quaternary deposits, which are represented by a continental deposits of different origin and thickness, including the most common alluvial-lacustrine deposits, which include all types of soils and often occupy one of them instead of the other horizontally, The thickness of the quaternary deposits ranges (11- 28.5 m). The wind sediments of the last period also contributed to the formation of the soil of the region. These sediments form Sand dunes (Barkhans) and sand sheets at an early stage of development [2]. The most important characteristics of the lower sedimentary plain soil are the Stratification and the different characteristics of horizons in the horizontal direction and their high content of calcium carbonate and magnesium with the dominance of the accumulation of salts in the soil surface with a history of its exploitation between (6000-4000 years) [3]. Sedimentary soils are characterized by a high degree of spatial Variability as a result of the interrelated effects of physical, chemical and biological processes that operate at different degrees of intensity. This variation is shown at the level of small-sized fields, This soil is characterized by its ability to High production, even with wide differences in its characteristics. Therefore, knowing the spatial Variability in soil characteristics is considered very important for applying the Precision agriculture or the concept of management zone that developed in response to wide changes in the main purpose through the efficient use of agricultural inputs with taking into account spatial Variability in soils and their properties. The fundamental changes in physical, chemical and morphological soil characteristics are mainly due to the biologically and geological soil formation factors, but the effects of these factors may be modified through appropriate management processes, the [4] mentioned that the fields with a high degree of spatial Variability in soil properties can be managed better using the specific quality management for the location through the concept of Precision agriculture, which aims to deal with spatial Variability by applying production inputs according to the requirements of the specified location and in accordance with the quality traits for the Soil and crop [5]. The study aims to identify and compare spatial Variability in morphological and physiochemical properties of some easy-flowing soil in different physiologic units in the lower sedimentary plain along the left of Al-Gharaf

ISSN 2072-3875

River in Al-Rifai district and to evaluate the physiological impact of the location on the properties and evolution of these soils.

2. MATERIALS AND METHODS

Preliminary proceedings

After the process of collecting information and view maps, including topographic maps and aerial photographs for Dhi Qar province as shown in figure (1), three locations were identified for drilling pedons representing the state of variation in the main expected sediment sources for the materials of the origin for some soil of the region. The study was conducted in Al-Rifai district, Dhi Qar province, which located between two latitudes (29"44¯31° and 50" 44¯31°) and two longitude line (25" 06¯46° and 27"07¯46°) according to Global Positioning System (GPS), The total area for the region amounts to 1,345 km^2 (134,500 hectares). Al-Rifai district is located within the hot and dry desert climate. The amount of rainfall amounts to (191.9 mm per year), it is distributed irregularly over the eight months. It accompanied this small amount of rain and irregularity in the rise of their annual temperature rates, where average of annual temperature amounted to (28.1°C) with a sharp increase in the summer months to reach to (39.8 °C) in August while the annual average humidity amounted to 34% within period ranging from 58% in January to 16% During the months of June and July as shown in Table (1). The temperature of the measured soil at a depth of 50 cm from the surface amounted to 18 °C. Therefore, the soil of the study area is considered with a thermal system of Hyperthermic type because of the annual average of temperature more than 15 °C and less than 22 °C and its moisture system from the Torric type (Aridic) to expose soils to drought throughout the year. The natural vegetation includes the willow and Tamarix trees, Alhagi, Pampas grass, and *Cynodon dactylon*. As for the use of land, palm and grain crops such as wheat, barley, Alfalfa, vegetables and some summer crops such as yellow corn and sorghum.

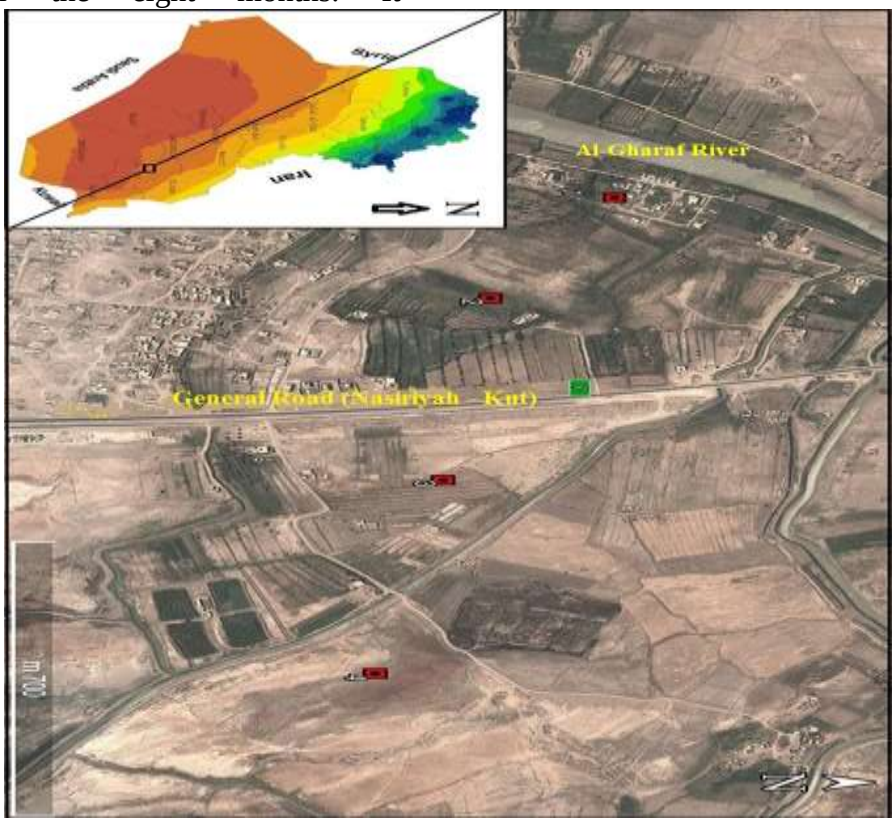


Figure 1: Aerial photograph for Al-Rifai district showing the locations of the studied pedons

ISSN 2072-3875

Table 1: General averages of climate data for the Dhi Qar province during the period from 2004 to 2015.

Min Temp °C	Max Temp °C	Average temp °C	Humidity %	Wind m/s	Sun hours	Rad $MJ/m^2/day$	Rains (mm/month)
20.3	35.9	28.1	34	3.2	8.8	19.4	155.3*

* Total annual rainfall

Physical, chemical and morphological analyzes:

The excited soil samples with a 2 kg mass were taken from different horizons of pedons for the purpose of conducting physical measurements and chemical analysis, as well as the collection of soil samples in its normal condition (non-excited) by the cylinder to test some of the physical traits and use the methods listed in [6] to estimate the texture by pipette method, apparent density by Core method, the true density by Pycnometer and the Saturated Hydraulic Conductivity using Constant Head Permeability test by applying equation (1), Total porosity was calculated using equation (2). Chemical analyzes of soil samples, which included electrical conductivity and soil pH, were performed according to the methods described in [7] and calcium carbonate and organic matter according to the methods described in [8]. The morphological characteristics of the three deposits were determined through the samples of each horizon and the soil was classified according to methodologies [9].

$$\boldsymbol{K_{(Sat)} = \left(\frac{V}{At}\right)\left(\frac{L}{h}\right) - - - (1)}$$

Where

K (sat): the Saturated Hydraulic Conductivity, L: Length of soil sample (mm), h: Height of soil and water column (mm), V: total water volume passing through the soil (mm)), t: time interval (second), A: cross-section area of the soil sample (mm^2).

$$f = \mathbf{1} - \frac{\boldsymbol{\rho b}}{\boldsymbol{\rho s}} - - - (\mathbf{2})$$

ρb: Apparent density, ρs: True density

3. RESULTS AND DISCUSSION

Morphological Characteristics

Table (2) shows the results of the morphological description for the horizon of the pedons under study. In general, this reflects the effect of the local factors of each pedon, which affected the variation state in the intensity of the effect of the pedogenic and geomorphological processes affecting the composition of these soils, including the physiographic location, the nature of land use, the effect of groundwater and the effect of the climate factor and the source of precipitation. These characteristics are generally shown in Table (2) that all soils are undeveloped, where their pedons were with sequence horizons from the type of A-C and absence of the illuviation horizon in it, This is a reflection for the nature of prevailing factors that do not help the development of soils. where all of the pedons are from a modern sedimentary material, transported by Al-Gharaf river or windy sediments, which are located under a dry climate and poor vegetation is some of the non-dense seasonal grasses and permanent shrubs, as well as, the topography is almost flat. One of the most important morphological features that have been identified in the studied soil pedons.

Thickness and boundaries of Horizons

Table (2) shows a difference in the thickness of the horizons of the three pedons. where the overall average thickness of the horizons amounted to (30.4 cm) within a range of (19 to 46 cm). The average thickness of the horizons in the first, second and third pedons amounted to (30.8, 28.5, 32.0 cm), respectively. The

ISSN 2072-3875

measurements showed that there were three horizons which were less than 20 cm. The variation in the thickness of the horizons is due mainly to the intensity of sedimentation processes and not to the variation state in the effect of the pedogenic processes because they are limited in these soil due to the nature of the environmental conditions prevailing in the study area, Which do not aid in the activity of pedogenetic processes. Table (2) shows that there are clear limits in the surface horizons Ap in the three soil pedons, while the sharp or abrupt boundary formed the largest part from the boundary types for the three pedons, with the percentage of (58.4%). The results also showed the appearance of the clear boundaries of horizon C1 for the second Pedon and horizons C2 for the third Pedon, and the topography of the horizons was smooth and for all horizons.

Soil color

Table (2) shows the wavelength (Hue) for the horizons of the three pedons has taken a constant value of 10YR in the wet state. The previous number (10) of YR means that the Hue is the yellowest within the range of YR with each increase from 0 to 10 the color becomes yellower and less Redness, This value is equivalent to 0Y, The stability of Hue value was attributed to the accumulation of calcium carbonate and the nature of its vertical distribution in the soil structure, while the value of color intensity ranged between 4 and 5, with a percentage of (41.7%, 33.4%), respectively, The three low values for the two horizons (Ap, C1) for the first pedon and the ap horizon in the second pedon indicate to increase the darkness value compared to the horizons that took the value 5 which approached the ideal white trait and the chroma purity ranged between (4, 6) in the wet case. The chroma value for the C1 horizon of the third pedon reveals that the color intensity of this layer approached gray color, unlike most of the horizons that have diverged from gray at the same value, from these results, it is noted that 58.4% from the horizons of the three pedons are dark yellowish brown and 33.4% are yellowish brown, while the C1 horizon of the third pedon is characterized by grayish brown. The soil color variability is mainly due to the difference in texture and the percentage of mud particles that give a color tends to decomposition compared to the rest of the particles when wet as well as the soil content of organic matter. These results agree with [10, 11] who found that there is a significant relationship between the color of the dark soil and the content of organic matter and clay particles. Thus, It can be concluded that the relatively dark color for the two horizons (Ap, C1) of the first pedon and Ap horizon in the second Pedon is mainly attributed to their high content of organic matter as shown in Table (5), thus, it can be considered as well-ventilated soils and are well suited for plant growth.

The depth of groundwater and mottling

Table (2) shows that there are differences in the depth of the groundwater in the three pedons, where the depth of the groundwater is very close to the surface in the first pedon and not more than 20 cm. This level may be temporary. This phenomenon may be attributed to the effect of pedons Because of the location by the increase in the level of Al-Gharaf river during the measurement period and the location was exposed to the feedback phenomenon (from surface water to groundwater). It is likely that this increase in the level of groundwater is a temporary phenomenon in terms of the presence of vegetation from palm trees and seasonal crops did not show signs of wilt or suffocation as a result of waterlogging, while the depth of groundwater in the second and third pedon amounted to (120, 130 cm), respectively, The differences between the two location may be due to the elevation of their positions at sea level. These results agree with [12]. The measured depth of the groundwater for the second and third pedon was large with the amount (249, 239 cm), respectively than the critical depth of the calculated groundwater

ISSN 2072-3875

level according to equation [3]. When the average annual temperature for the year amounted to (28.1 C) as shown in Table (1), thus, It can be concluded that the depth of the groundwater in the studied locations contributes effectively to the Salinization process, This is due to increasing the activity of the Capillary property where the groundwater approached the surface, which helped to repeat moisturizing and drying cycles, which in turn lead to the accumulation of salts on the surface. On the other hand, the field results showed that the mottling disappeared in the three pedons, so the three soils can be classified under the quick drainage type. Moreover, the disappearance of the mottling proves that the actual depth of the groundwater is greater than the measured depth during the study period.

Soil structure

Table (2) shows that the soil type in the three pedons was the blocky type with a ratio of (58.3%) followed by massive type with a ratio of 33.4%, while the structure of a granular type appeared in the horizon Ap in the first Pedon, The improvement in the construction of the surface horizons of the three pedons may be due to the effect of the agriculture factor, which has led to improved soil structure by the effect of root secretions, increasing the bio-activity or the work of hair root on connecting soil particles with each other [13]. While the weakness of the massive structure of the subsurface layers in the two horizons (C2, C3) for the first and third pedons is accompanied by the lack of organic matter in those horizons and Its low content of calcium carbonate acts as a bonding material.

Physical properties:

Size distribution for the soil particles

The results of Size distribution for the soil particles showed that the soil texture in the three pedons was Sandy loam (SL) and loam (L), with a ratio of (33.34%) for each of them. while Clay Loam (CL), Sandy Loam (LS) and Sandy Clay Loam (SCL), with the ratio of (16.67, 8.34, 8.34%), respectively, from the types of total texture. The results of comparing the general averages for the distribution of particles between the three locations showed a decrease in the percentage of coarse particles with the increase of the distance from the supposed sedimentation source of Al-Gharaf River. where the percentage of sand particles in the two locations (second and third) decreased with a ratio of (6.47, 17.61%), respectively, compared to the first location, which recorded the highest value amounted to (568.5 $g.kg^{-1}$), while the soft particles took a different direction, where the percentage of clay in the first and second locations increased with ratio of (4.77, 22.38%), respectively, compared with the first location which recorded the lowest value for the percentage of clay amounted to (188.25 $g.kg^{-1}$). While the fine particles took a different direction, where the percentage of clay in the first and second location increased with the ratio (4.77, 22.38%), respectively, compared with the first location which recorded the lowest value for the clay, with a ratio of (188.25 $g.kg^{-1}$). In the same way, the percentage silt particles for the second and third locations were increased with a ratio of (24.23, 38.03%), respectively, compared to the first location which recorded the lowest value for the silt with a ratio of (311.32 $g.kg^{-1}$), It agrees with the results in [14] which confirmed that the clay and silt content of the fine and medium particles increased with Logarithm of the distance from the supplying source, While the percentage of rough parts in the soils of the American floodplain decreased.

ISSN 2072-3875

Table 2: Some morphological characteristics for the horizons of the pedons under study

Pedon	Location	Horizon	Depth (cm)	The depth of groundwater (cm)	Mottling depth	Color	Texture	Soil structure	Horizon boundaries
1	314472500 460655838	Ap	23–0	20	nil	10YR 3/6	SL	granular	c
		C1	64–24			10YR 3/6	L	blocky	a
		C2	94–65			10YR 4/4	SL	blocky	a
		C3	126–95			10YR 5/6	L	blocky	a
2	314458817 460681610	Ap	29–0	120	nil	10YR 3/4	SL	blocky	c
		C1	66–30			10YR 5/4	SCL	blocky	c
		C2	86–67			10YR 5/6	L	massive	a
		C3	117–87			10YR 4/6	SL	massive	a
3	314466125 460745766	Ap	19–0	130	nil	10YR 4/4	LS	blocky	c
		C1	66–20			10YR 5/2	CL	blocky	a
		C2	111–67			10YR 4/6	L	massive	a
		C3	131–112			10YR 5/6	SL	massive	c

Table 3: Some physical properties for the soil of the pedons.

Location	horizon	Size distribution for the soil particles			Texture	ρb $mg.m^{-3}$	ρs $mg.m^{-3}$	Porosity (%)	Ksat ($cm.hr^{-1}$)
		Sand	Silt	Clay					
First pedon	Ap	804.7	99.9	95.4	LS*	1.53	2,65	42.26	5.25
	C1	347.7	357.6	294.7	CL	1.39	2.65	47.55	1.42
	C2	457.8	327.5	214.7	L	1.49	2.66	43.98	2.00
	C3	663.8	87.9	148.2	SL	1.58	2.66	40.60	3.25
Second pedon	Ap	716.6	148.1	135.4	SL	1.59	2.64	39.77	5.21
	C1	376.6	366.3	257.1	L	1.4	2.66	47.37	1.54
	C2	615.2	216	168.8	SL	1.52	2.68	43.28	4.58
	C3	418.4	354	227.6	L	1.42	2.66	46.62	2.83
Third pedon	Ap	652.9	112.4	234.7	SCL	1.52	2.63	42.21	1.25
	C1	395.1	440.1	164.8	L	1.41	2.68	47.39	2.25
	C2	527.6	291.5	180.9	SL	1.51	2.67	43.45	3.75
	C3	298.0	360.9	341.1	CL	1.29	2.67	51.69	0.92

* Loamy Sand (LS), Clay Loam (CL), loam (L), Sandy loam (SL), Sandy Clay Loam (SCL)

ISSN 2072-3875

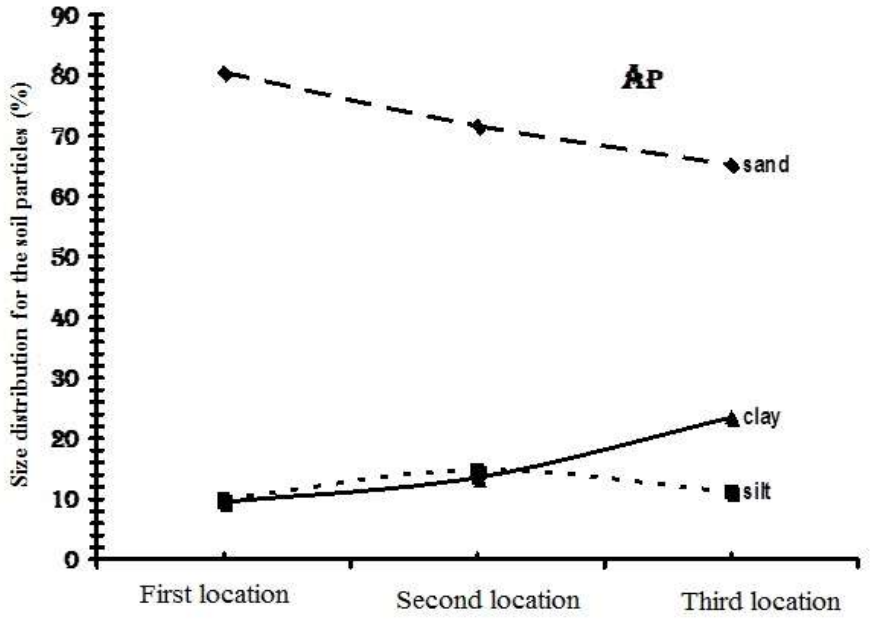
Figure (2) shows that the size distribution for the soil particles and their relation to the sedimentation source in the three pedons have assumed an ideal behavior for the Ap and C3 horizons, while the distribution of particles in C1 and C2 horizons did not take a specific pattern, It is likely that the soil of the region was not formed only by the deposits of Al-Gharaf river, but by other water source or through the current studied running water. The [15] indicated that the sedimentary plain soil is formed under ideal conditions by depositing particles of coarse soils, sand and coarse silt in the levees and river banks, while the fine particles deposit (clay and fine silt) in the farthest areas of the river. Therefore, important changes in the physical properties of soils depend on their location from the sediment source, but the riverbeds often change their course. Therefore, the distribution patterns of soils in the sedimentary plain are often very complex [16]. The results show an increase in the roughness of the Ap horizon compared to the subsurface layers. The percentage of sand particles in the Ap horizon compared to the horizons (C1, C2, C3) increased with the ratio of (131, 76, 21%), respectively in the first pedon, (90, 16 and 71%), respectively in the second Pedon, and (65, 24, 116%), respectively in the third Pedon, This may be due to the effect of wind erosion that may have contributed to the transfer of fine particles from the surface of these relatively high locations to lower locations with the help of two main factors: the prevailing Northwest Wind direction, which represents more than 52%, and the topography of the region, where the slope is from north to south and previous tillage operations may have accelerated erosion rates in the area. A comparison of the distribution of clay and sand particles within the same profile as shown in (Figure 2) did not prove on the presence an Eluviation-illuviation process in the region except for the first pedon, where the percentage of clay and silt particles in the horizon C1 by three times compared to Ap horizon. This may be due to repeated irrigation processes that have contributed to the removal of the clay and silt particles from the surface and their deposition at a greater depth in the soil body. Furthermore, the increase in the percentage of coarse parts in the Ap horizon may result from the removal of soft particles by active wind erosion in the region.

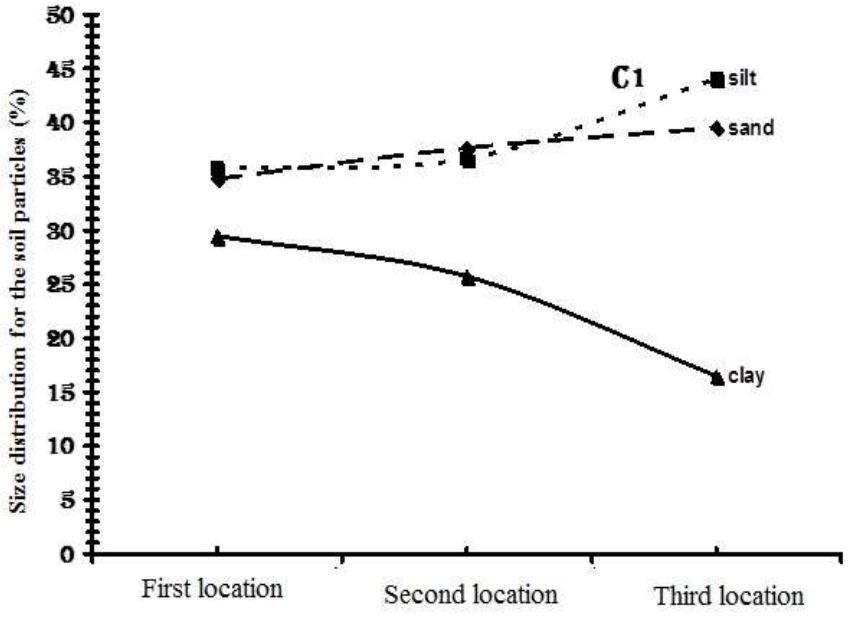
Apparent Density

Table (3) shows that the general average for the value of apparent density for pedons (1, 2, 3) amounted to (1.50, 1.48, 1.43 $\mu g.m^{-3}$), respectively, the results showed a decrease in the value of apparent density for horizon C1, with ratio of (9.15, 11.95, 7.24%) in the three locations respectively, compared to the tillage horizon, The reason was due to the effect of soil separates. This trait was associated with a significant positive correlation with sand (r= 0.893) and negative with clay (r= 0.819), while the Linear Correlation Analysis did not prove a relationship with organic matter, this may be due to the fact that the levels of organic matter were insufficient to influence the apparent density, This means that the effect of texture on the values of apparent density was greater than the effect of organic matter in the study area, the relatively high average for this position in the first location and increasing it in the tillage horizon may be due to the difference in the nature of agricultural operations between the three locations, the [17] found that the apparent density could increase with the amount of (0.31 $\mu g.m^{-3}$) when a standard tractor passed on a point eight times. These results generally indicate that the most frequently used location (first location) was the most susceptible to compression compared to other locations. The overall average of this trait of the horizons (Ap, C1, C2, C3) amounted to (1.55, 1.40, 1.51, 1.43 $\mu g.m^{-3}$), respectively. This change in the values of the apparent density according to the horizon locations from the soil body is a reflection for the effect of the variation state in the size

ISSN 2072-3875

distribution of the soil particles and the effect of the sand particles, which increases the apparent density of these pedons as well as the low soil content of the relative organic matter as well as the land use factor. The values of the true density for the soil were dispersed and had no association with the organic content for the soil as assumed [18]. This may be due to the low soil content of organic matter to levels that have lost the ability to influence the apparent density. As for the percentage of total soil porosity calculated in Equation (2), which expresses water and air-filled spaces as well as the soil compressibility, has amounted for pedons (1, 2, 3) with a general average amounted to (43.60, 44.26, 46.19%), respectively. It was directly correlated with the percentage of change in the apparent density and the same significant relationship (with Different signal) was recorded with sand and clay particles.





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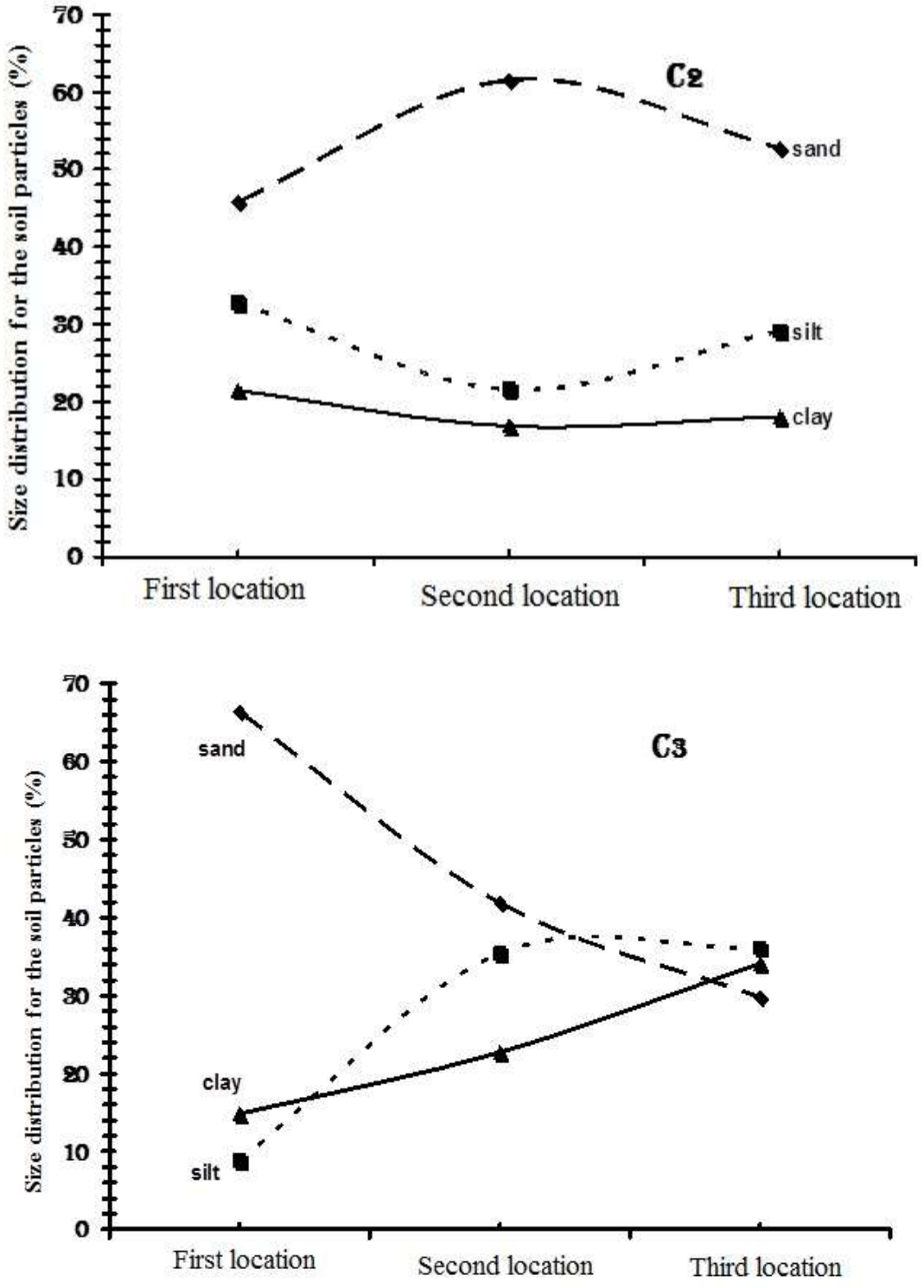

Figure 2: The relationship between the percentage for the horizons content of sand, silt, clay and distance logarithm from the sediment source (Al-Gharaf River) for the soil of the three locations.

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Saturated Hydraulic Conductivity (Ksat)

Table (3) shows that the overall average for the Saturated Hydraulic Conductivity values for the first, second, and third pedons amounted to (2.98, 3.54, 2.04 $cm.hr^{-1}$), respectively, the overall average for this trait (Ap, C1, C2, C3) amounted to (3.90, 1.74, 3.44, 33 $cm.hr^{-1}$), respectively. These differences in Ksat values between the three locations were mainly due to the soil texture. The correlation analysis results showed a significant negative correlation with clay (-0.856), positive with sand (0.770) below 0.01 level. where coarse soil with large pores has a higher Hydraulic Conductivity than soils with a fine texture which have small pores and higher porosity as confirmed by [19]. who showed that the correlation between the Hydraulic properties and the particles size is very good for the soil with the high content of the sand, but it is not in same precise for the soil with high clay. The results showed that there were wide differences in the values of the Saturated Hydraulic Conductivity between the horizons of the one profile. The surface horizons were higher than the subsurface layers of the first and second pedon. It has decreased in the horizon C1 compared to the Ap horizon with a ratio of (73, 70%) for two locations, respectively. While there was a different behavior in the third Pedon, where the value of this trait decreased with ratio of 44% in the horizon Ap compared to the horizon C1, in general, this indicator took the same direction to the soil of the first and second Pedon, where decreased from surface horizon to the horizon C2 and then rise towards the horizon C3. The reason may be due to the soil content of sand as one of the most important factors affecting the values of Saturated Hydraulic Conductivity. It was found that there is a high significant correlation between (P = 0.01) r = 0.82 between them. Table (2) shows that the Ap horizon in the first and second pedon is the fastest in Hydraulic Conductivity with a ratio of (5.25, 5.21 $cm.hr^{-1}$), respectively. While the horizon C3 in the third pedon was the lowest layer of Hydraulic Conductivity (0.92 $cm.hr^{-1}$) in the whole area of the study. This may be due to the deterioration of construction as shown in Table (3) and the increase in the clay content which is characterized by the characteristic of swelling and shrinkage, which determines the number and size of the flow with physical action for those particles or through the air blocking. The Saturated Hydraulic Conductivity of all pedons can be classified on the basis of their general averages to the "Moderately High" class, according to an assessment [20] which identified this class with Ksat values ranging from $0.36 \rightarrow 0 > 3.6$.

Chemical traits

Organic matter

The results showed significant differences in the organic matter content in the three pedons as shown in Table (4), where the percentage of organic matter in this horizon decreased from (15.1 $g.kg^{-1}$) in the first pedon to (6.8 $g.kg^{-1}$) in the first pedon. The results of the correlation analysis showed that there was no significant correlation with some soil properties, unlike the results of several previous studies. where the [10] found that there is a significant positive correlation between the soil content of clay and organic carbon, so it is likely that the difference between the three administrative factors in terms of quantity and quality of mineral and organic fertilizers added and mixing plant residues with soil and the natural use of land has caused this variation in the organic matter content for the surface layer. The results also showed differences in the overall average of organic matter content for the soil of the three locations. The soil of the first pedon was excelled by recording it the highest content amounted to (6.43 $g.Kg^{-1}$) followed by the second pedon (4.08 g. Kg^{-1}), while the soil of the third pedon recorded the lowest content amounted to (2.65 g kg^{-1}). The results showed a decrease in the organic matter content with increasing the depth in all locations, where recorded the highest

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organic matter content in the surface horizons of all the pedons at a general average (10.33 $g.kg^{-1}$) and decreased sharply to the lowest levels in the sub-surface horizon C3 to (0.37 $g.kg^{-1}$). The reason is due to the nature and density of roots propagation in the soil horizons as shown in Table (5). these results agree with [21]. The content of organic soils can be classified as marginal, low and sufficient for the soil of the third, second and first pedon, respectively, based on the organic matter content of the Ap horizon, while the classification has been reduced to marginal for the three pedons, when the general average for the percentage of organic matter for the whole soil sector is adopted according to standard [22], who rated the percentage of organic matter in the soil that measured by Walkley-Black as marginal when it was less than 0.86% and low when it ranged between 1.29-0.86% and the greater than 1.29% was classified as sufficient. While all location is located within the highest erosion group based on their low organic matter content according to criterion [23] which defined the critical soil content of organic matter by less than 2%. The reason of low level of organic matter may be attributed to low vegetation, low of rainfall and rapid decomposition under the influence of high temperatures as shown in Table (2), Which helped to oxidize the organic matter and the mineralization process of organic matter by the impact of agricultural processes.

Table 4: Some chemical properties for the soil of the pedons

Location	horizon	O.M ($g.kg^{-1}$)	$CaCO_3$ ($g.kg^{-1}$)	EC ($ds.m^{-1}$)	pH
First pedon	Ap	15.1	168	3.67	7.94
	C1	7.6	205	2.85	7.86
	C2	1.9	233	3.38	7.60
	C3	1.1	231	3.01	7.71
Second pedon	Ap	9.1	262	3.28	8.06
	C1	6.2	251	3.09	7.95
	C2	1.o	188	2.71	7.52
	C3	0	189	3.89	7.98
Third pedon	Ap	6.8	232	2.54	7.95
	C1	2.3	227	5.52	8.00
	C2	1.5	218	6.04	7.87
	C3	0	222	6.52	7.65

Calcium carbonate

All locations showed a high content of calcium carbonate with an average of (219 $g.kg^{-1}$) within a range of (262-168 $g.kg^{-1}$). This is indicated through the results of a number of researchers from the high content of carbonate for the soil of dry and semi-dry areas [3, 24]. Table (4) shows approaching the general average of soil content in the second and third pedons from calcium carbonate by achieving an average amounted to (223, 225 $g.kg^{-1}$), respectively, while this trait has decreased to the first pedons soil to reach to (209 $g.kg^{-1}$). This result agrees with [25] who confirmed an increase in the content of fresh soils compared with their coarse soils. The results in Figure (3) shows a high content of calcium carbonate with a state of homogeneity and convergence in their vertical distribution in the three pedons, noting that the content of calcium carbonate for the second and third pedon soils in the Ap horizon compared with the C1 horizon, with ratio of (2.20, 4.38%), respectively. This can be attributed to the lack of rain, which leads to a weak redistribution of carbonates [26]. In contrast, the calcium carbonate content for the soil of the first pedon

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in the Ap horizon decreased with the ratio of 18.05% compared to horizon C1, This may be due to the effect of irrigation processes that lead to the process of dissolving and transporting for calcium carbonate to reach to the depths, or the rise of water by the Capillary property Carrying with it calcium ions and bicarbonates to be deposited in a certain horizon in the form of calcium carbonate. This condition is known as the loco-chemical formation [27]. In general, the results of the content and distribution of calcium carbonate in the study pedons confirm that the Materials of river sedimentary origin and parallel to Al-Gharaf river, rich in carbonate minerals due to the nature of the calcareous deposits, As well as the depth of groundwater in those locations, helped to collect carbonate minerals in those soils and this reflects the state of symmetry in the sources of origin.

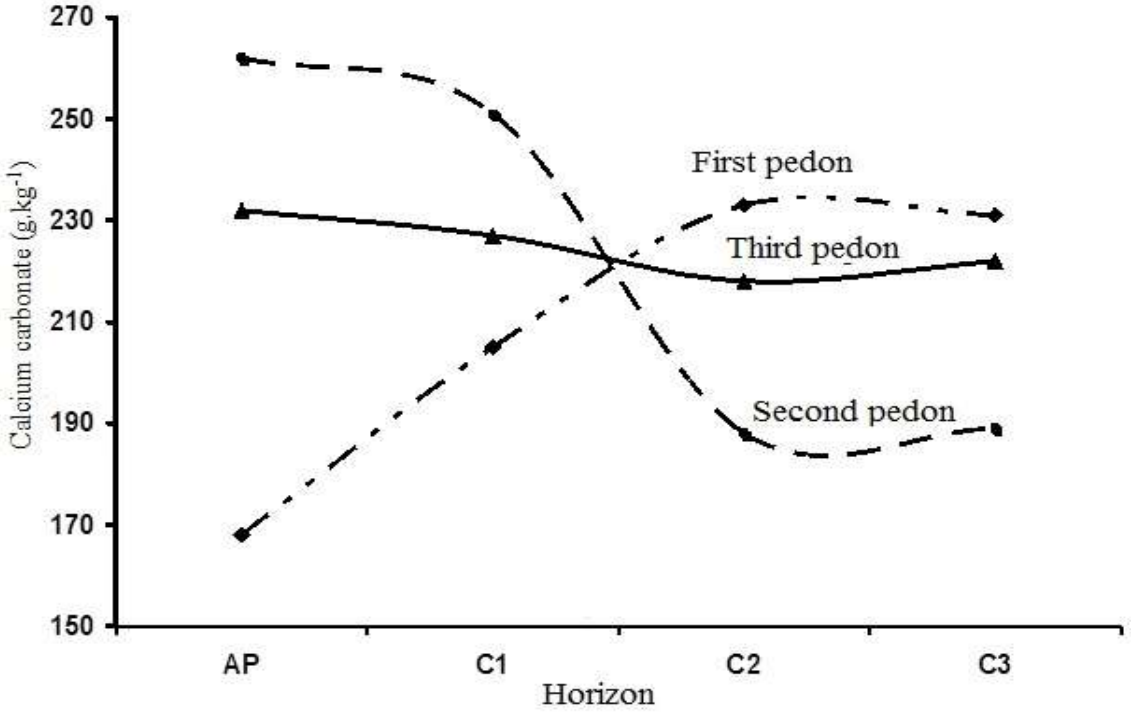

Figure 3: Vertical distribution of calcium carbonate within the soil sector of the three pedons.

Electrical Conductivity (EC)

Table (4) shows the results of the electrical conductivity values for the parallel path for Al-Gharaf River represented by pedons (1, 2, 3). The values of this trait reduced at the Ap horizon, with averages amounted to (3.67, 3.28, 2.54 ds.m^{-1}) respectively, While the vertical distribution of salts within the soil sector in the three pedons differed as shown in Figure (4). There was a fluctuation in the saline distribution of the first soil pedon which decreased when moving from horizon Ap to horizon C1, which returned to increase at horizon C2 and reduced again at horizon C3. The increasing the salt concentration for horizon Ap may be due to the approaching groundwater from the surface 20 cm and increase the activity of the capillary property as well as the high temperatures helped evaporation of water from the surface of the soil and therefore the accumulation of salts in them, but to a limited degree due to the acceptable quality of groundwater (4.13 ds.m^{-1}). In a similar manner, the values of electrical conductivity decreased when moving from the Ap horizon to the horizons (C1, C2) and then returned to increase at horizon C3, while the saline concentration for the soil of the third pedon increased with depth, where the values of

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the electrical conductivity for the horizon C3 were equal to more than two double the value of this trait at horizon Ap, The percentage of decrease in Ap horizon may be due to the effect of irrigation operations and the efficiency of the water part which added as washing requirements in diluting the saline concentration for the surface layer, thus creating suitable soil for seed germination as well as the decrease in the activity of the activity of capillary property due to the reduction of evaporation from the surface horizons under the influence of cultivated plants, While the salinity of horizon C3 seems to have been affected by the amount of salts washed from the layers above, while decrease the general average for the value of the electrical conductivity for the soil of the first pedon may be due to the fact that its soil occupies a position within the banks of the Euphrates River physiographically as shown in Figure (1), which is usually characterized by existing a good system for natural drainage that increases salts washing intensity according to [28]. As well as what the soil is characterized by its, high water delivery, which helped the movement of water and dissolved salts down the root area, As for the decrease in the overall value of the electrical conductivity for the second sedimentary soil, it may be due to the presence of groundwater at a relatively large depth of 120 cm, as well as the effect of irrigation which helped to wash the salts out of the soil body. The soil of location can be classified on the basis of its salt content in terms of the overall average for the EC value for the soil sector to non-saline soils for the first and second pedons and the low-salinity soil for the third pedon according to [29] who classified the soil into non-saline and low saline when the soil electrical conductivity values lying within the range is (0-4 and 4-8 ds.m^{-1}), respectively.

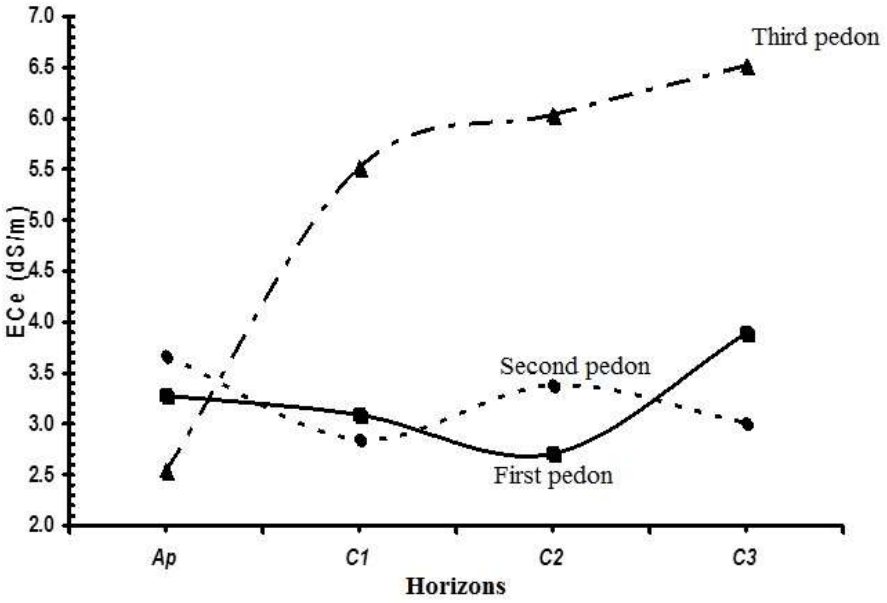

Figure 4: The vertical distribution of the salts within pedons soil.

Soil reaction (pH)

Table (4) shows the values of soil reaction for the horizon of the studied pedons which classifying under the neutral to alkaline soils according to [29] who classified the soil on the basis of pH values to 6.6-7.3 neutral and light base 7.4-7.8 and medium basal 7.9-8.4. where the soil of the third pedon achieved the highest overall average for the pH value amounted to (7.95 medium basals) , while the soil of the first pedon recorded the lowest overall average for this trait amounted to (7.33 neutral). The values of pH values showed high stability in the three pedons, where the lowest value was approached

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to the highest value for the soil pH within one location, which amounted to (7.05 vs 7.54) for the soil of the first pedon, (7.15 vs 8.14) for the soil of the second pedon and (7.80 vs 8.07) for the soil of the third pedon, This indicates the high regulatory capacity of these soils due to their high calcium carbonate content, as confirmed by [30]. The slight differences between the pedons are due to the different texture, salinity and their content of carbonate and sulfate of calcium. It is possible to observe that the values of soil pH are convergent in all pedons of the soil, it is related to the formation conditions of these soils in terms of the calcium carbonate-rich origin material resulting from the sediments of Al-Gharaf River and the dry climate. This reflects the effect of the calcareous state of these soils which played a major role in determining the values of soil interaction Despite the state of variation in the physiographic location. This result agrees with [31] in their study the effect of irrigation processes on soils in semi-dry areas in Kansas State in the USA.

Soil classification

The soil of the three studied pedons according to the modern American classification [29] subjects to the level of order and sub-order and the great group and sub-group and Soil classification for the family level were excluded because of the limited duration of the study and the need for mineral analysis. In general, the soil of the three pidoons for Al-Rifai district is characterized by the sedimentary origin (calcareous) that transferred by water. The soil of the region belongs to the modern formation Entisols order because the main trait for the soils of this order is the modernity of the evolutionary state and the absence of the main diagnostic horizons. Entisols according to [32] represent the order of the mineral soils in which the characteristic horizons disappear For reasons return to either to the nature of the hard-weathering mother material such as Quartzes or it did not take long to develop. This order is located within a wide range of climatic regions, from the point view of agricultural productivity, the formed Entisols soil in the areas of flood basins and the Delta plains among the highest productive soils in the world because of the nature of its texture, their food content and water storage capacity. Field observations and laboratory analyzes showed the absence of the transferred clay, because the time factor is still insufficient to form the illuviation horizons B, as well as all the soils, are located in the lower sedimentary plain, which receives new deposits of sediment at frequent intervals of time, Which helped to weaken the pedogenic activity in these soils [3], These soils were characterized by the absence of Diagnostic surface Horizons such as the Molic Horizon and the absence of the rest of the Diagnostic Subsurface Horizons, including the advanced clay Horizon (Argillic horizon), it is the horizon that collect the transferred clay from the upper horizons, Salic, Calic, Petrocalcic, Gypsic or Ptrogypsic, With the dominance of the dry-wet system and that the control section is not wet for most days of the year, the soil is unsaturated within the first meter of the soil body (rising the groundwater level in the first pedon to the depth of 20 cm represent a temporary condition due to the rising the levels of Al-Gharaf river during the measurement period). The results also showed that the soil of the three locations belong to the level sub-order (Fluvents), where these soils are composed of newly formed river deposits, it is characterized by the Stratification state and most of them are transferred and derived from rocks or stripped soil or rivers banks, It contains an amount of organic carbon with clay parts. It is present in the area with slopes of less than 25% and is not exposed to waterlogging within 50 cm of the soil surface. Soil moisture ranged between (2.66 - 7.34%), their thermodynamic system range between 8 °C and 15 °C, free from rock or semi-rock layers within a depth of 25 cm of the soil surface. At the taxonomic level for the Great Group, it is lying within the Torrifluvents group, Which is characterized by

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the presence of river deposits in a hot dry climate and located at the taxonomic level for the Great Group, It is located under a wet system of the Torric type which is one of the soil moisture systems in which the soil is dry in all its parts for more than half of the time when the soil temperature at the depth of 50 cm is more than 5 °C and no moisture for more than 90 consecutive days when the temperature is greater 8 °C, Most parts of the soil pedons are subjected to drought and for most time during the year, it is deep soils and the percentage of organic matter decreases with depth and groundwater near the surface with the dominance of fine particles [29]. The soils of this group are considered equivalent to the soils of great which Known as alluvial soils in the old American system [33]. The soil classification for the subgroup and depending on the extent of the correlation of the traits for the soil belonging to the great group of the highest levels (order, sub-order and the great group), the results of the field and laboratory study show that the soil of these locations lying within the sub-group (Typic Torrifluents) because they possess the typical traits of the great group and represent the characteristics of the ideal state.

Spatial variability

The variability in the soil traits under study was classified basis on Coefficient of Variance CV values as shown in Table (5), where the results showed that the lowest coefficient of Variance recorded for the traits pH, apparent density, porosity and calcium carbonate was (2.25, 6.04, 7.16, 12.41%), respectively, indicating a slight variability and state of homogeneity for these traits according to the groupings described by [34] who classified the characteristics of the soil on the basis of the CV values to a low 0-15, medium 15-75 and high for more than 75, while the soil traits that represent by sand, clay, salinity, silt, and Saturated Hydraulic Conductivity showed a medium variability and heterogeneity state in terms of the Coefficient of Variance for these traits which amounted to (31.39, 34.24, 35.30, 47.06, 54.30%), respectively. The spatial heterogeneity in these characteristics may be due to a combination of factors such as previous agricultural processes, the history of exploitation, vegetation, and erosion. The studied locations were characterized by high content of sand ranging from 298 to 805 $g.kg^{-1}$ while the silt was the largest variable between soil separators, indicating that the effect of erosion and sedimentation on the silt was greater compared with the rest of the separates. A number of researchers [35, 36] have confirmed that some soil properties such as density, Saturated Hydraulic Conductivity, and texture can vary significantly within a single field and this variability can have a major impact on the potential of agricultural production, The result of the heterogeneity of salinity agrees with [13] in term of the electrical conductivity and the concentration of cations and ions can show significant wide-ranging change within a relatively small area (2 ha), with a plain topographic nature. The results showed that organic matter was characterized by the highest degree of Covariance (CV = 105.69%) compared with the other measured traits, which reflects the heterogeneous in this trait. This may be due to the irregularity of organic material additions between the three locations in addition to the wide variation within one location, The variation in spatial heterogeneity in terms of CV values showed differences in varying degrees in physical and chemical soil properties horizontally from location to location and vertically within a single location that may be attributed to dynamic interactions between environmental factors, material, location, physiographic location, vegetation, and land use, Robertson et al., [37] indicated the existence of covariance in the traits of the exploited and not exploited agricultural soils due to the interaction of soil composition factors, Management processes have a significant impact on the amount and direction of these changes [38].μ

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Table 5: The statistical parameters for some of the physical and chemical characteristics of the studied soil.

The statistical parameters	Soil characteristics									
	Apparent density	porosity	sand	clay	Silt	K_{sat}	OM	$CaCO_3$	EC	pH
	Unit measurement									
	$\mu g.m^{-3}$	%	$\mu g.m^{-}_{3}$	$cm.hr^{-}_{1}$	$\mu g.m^{-}_{1}$	$dS.m^{-}_{1}$	-log $[H^+]$	$\mu g.m^{-3}$	%	$g.kg^{-}_{1}$
Average	1.47	44.70	52.29	20.5	26.4	2.85	4.38	239.17	3.88	7.84
Std. Deviation	0.09	3.20	16.41	7.03	12.40	1.55	4.63	42.98	1.37	0.18
Variance	0.01	10.23	269.5	49.4	153.8	2.40	21.46	1847.4	1.87	0.03
Range	0.30	10.50	50.67	24.6	35.22	4.33	15.10	129.00	3.98	0.54
Minimum	1.29	40.45	29.80	9.54	8.79	0.92	0.00	168.00	2.54	7.52
Maximum	1.59	50.95	80.47	34.1	44.01	5.25	15.10	297.00	6.52	8.06
C.V	6.04	7.16	31.39	34.2	47.06	54.30	105.7	17.97	35.30	2.25

REFERENCES

[1] Oosterbaan, R.J. and H.J. Nijland. 1994. Drainage Principles and Applications. International Institute for Land Reclamation and Improvement (ILRI), Publication 16, second revised edition, Wageningen, The Netherlands.

[2] Soyuzgiprovodkhoz. 1984. Tigris Euphrates main outfall drain, Middle part, Republic of Iraq. Detailed project report. p1. Natural Condition. Volume.

[3] Buringh, P. 1960. Soils and Soil Conditions in Iraq. Ministry of Agriculture, Baghdad, Iraq, p.p. 322.

[4] Inmna, D.J., R. Khosla, and D. G. Westfall. 2005. Nitrogen uptake across site-specific management zones in irrigated continuous corn production systems. Agron. J. 97:169–176.

[5] Fraisse, C.W., K.A. Sudduth, N.R. Kitchen, and J.J. Fridgen. 1999. Use of Unsupervised Clustering Algorithms for Delineating Within-Field Management Zones. ASAE Paper No. 993043. Meeting, Toronto, Ontario, Canada. July 18–21.

[6] Black, C.A., D.D. Evans, L.L. White, L.E. Ensminger, and F.E. Clark. 1965. Method of Soil Analysis. Part 1. In Agronomy Series (9) .Am. Soc. Agron. Inc., Madison, Wisconsin, USA. p.p. 1569.

[7] Page, A.L., R.H. Miller and D.R. Kenncy.1982. Method of Soil Analysis.Part 2, Agronomy 9.

[8] Jackson, M.L. (1958). Soil Chemical Analysis. Prentice Hall, Inc. Englewood Cliffs, N. J, USA.

[9] Soil Survey Staff. 1999. Soil Taxonomy. A Basic System of Soil Classification for Making and Interpreting Soil Survey, 2nd ed. Agriculture Handbook No.436.USDA, USA.

[10] Konen, M.E., C.L. Burras and J. A. Sander. 2003. Organic carbon, texture, and quantitative color measurements relationships for cultivated soils in north-central Iowa. Soil Sci. Soc. Am. J. 67:1823 – 1830.

[11] Allen, C.E. 2005. Physical and chemical characteristics of soils forming on boulder Tops Karkevagge, Sweden. Soil Sci. Soc. Am. J. 69:148-158.

[12] Al-Moussawi, Nasr Abdel-Sajad Abdul-Hassan. 2005. Spatial variation of the characteristics of the soil of Basra province. Ph.D. thesis, College of Arts, University of Basra.

ISSN 2072-3875

[13] Chung, S.O., J.H. Sung, K.A. Sudduth, S.T. Drummond, and B.K. Hyun. 2001. Spatial Variability of Yield, Chlorophyll Content, and Soil Properties in a Korean Rice Paddy Field. In P.C. Robert et al. (ed.) Proc. 5th International Conf. on precision agriculture. [CD-rom] ASA, CSSA, Madison, WI, USA.

[14] West, L.T., E.M. Rutledge, and D.M. Barbe. 1980. Sources and properties of loess deposits on Crowley's Ridge in Arkansas1, Soil Sci. Soc. Am. J. 44: 353-358.

[15] Javed, I., John, A. T., Johnie, N. J., Phillip, R. Owens and Frank, D. W. 2005. Spatial variability analysis of soil physical properties of alluvial soils. Soil Sci. Soc. Am. J. 69:1–13.

[16] Trangmar, B.B., R.S. Yost, and G. Uehara. 1985. Application of geo-statistics to spatial studies of soil properties. Adv. Agron. 38:45–93.

[17] Al-Ghazal, A.A. 2002. Effect of tractor wheel compaction on bulk density and infiltration rate of a loamy sand soil in Saudi Arabia. Emir. J. Agric. Sci. 14:24–33.

[18] Abbas, Haidar Hilal, Samer Mohi Taha, Tiba Muzaffar Saleh, and Oras Mohi Taha. 2016. Spatial predicted for bulk density and impact of texture and organic matter on its Values, Al-Furat Journal of Agricultural Sciences, Volume 8 Issue 1: 196-203.

[19] Cornelis W.M., G. Oltenfreiter, D. Gabriels, and R. Hartmann. 2004. Splash–saltation of sand due to wind-driven rain: Vertical deposition flux and sediment transport rate. Soil Sci. Soc. Am. J. 68:32–40.

[20] Al-Ani, Amal Mohammed Saleh 2006. Applications of Numerical Classification in the Classification of Some Stratigraphic Strata in the Iraqi Sedimentary Plain. Ph.D. thesis, College of Agriculture, University of Baghdad.

[21] National Soil Survey Center, Natural Resources Conservation Service, U.S. Department of Agriculture. 2002. Field Book for Describing and Sampling Soils, Version 2.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE, USA, p.p. 228.

[22] FAO/UNEP and UNESCO. 1980. Soil Testing and Plant Analysis. Bull N0. 38/1, FAO, Rome, Italy.

[23] Stocking, M.A., and N. Murnaghan. 2001. Handbook for Field Assessment of Land Degradation, Earthscan Publication Ltd., London, UK, p.p. 199.

[24] Tan, H.K. 1996. Soil Sampling, Preparation, and Analysis, Marcel Dekkev Inc. New York, USA, p.p. 178.

[25] FAO., 1973. Calcareous Soils, Iraq, Bull.No.21, FAO. Rome, Italy.

[26] Al-Okidi, Walid Khaled Hassan. 1986. Biology - Soil Survey and Classification. Baghdad University.

[27] Al-Khafaji, Abdul-Hussein Nima. 1979. Distribution of minerals and salinity "salts" in different physical units in some sedimentary soils in Iraq. Al-Rubaie, MA - Faculty of Agriculture - University of Baghdad.

[28] Al-Zubaidi, Ahmed Haider. 1989. Soil salinity. Theoretical and applied foundations. Baghdad University. House of Wisdom.

[29] Soil Survey Division Staff. 1993. Soil Survey Manual. USDA Handbook No. 18.U. S. Gov. Print Office, Washington, DC, USA.

[30] Doner, H.E., and W.C. Lynn. 1989. Carbonate, Halide, Sulfate, and Sulfide Minerals. In: Dixon, J.B., and Weed, S.B., (eds). 1989. Minerals in the Soil Environment, 2nd ed. Soil Science Society of America Book Series, No. 1, Soil Science Society America, Madison, WI, USA. 1244.

[31] Presley, D.R., M.D. Ransom, G.J. Kluitenberg and P.R. Finnell. 2004. Effects of thirty years of irrigation on the genesis and morphology of two semiarid soils in Kansas. Soil Sci. Soc. Am. J. 68:1916-1926.

[32] Strahler, A. and Strahler, A. 2005. Introducing Physical Geography. Third Edition, John Wiley & Sons, Inc.

ISSN 2072-3875

[33] Al-Tai, F.H., C. Sys and G. Stoops. 1969. Soil groups of Iraq, their classification and characterization. Pedologie 19:65-148.

[34] Dahiya, I.S., J. Richter and R.S. Malik. 1984. Soil spatial variability: a review. Int. J. Trop. Agric. 2(1):1-102.

[35] Mzuku, M., R. Khosla, R. Reich, D. Inman, F. Smith, and L. MacDonald. 2005. Spatial variability of measured soil properties across site-specific management zones. Soil Sci. Soc. Am. J. 69:1572–1579.

[36] Iqbal, J., A. Thomasson, J. N. Jenkins, P. R. Owens, and F. D. Whisler. 2005. Spatial variability analysis of soil physical properties of alluvial soils. Soil Sci. Soc. Am. J. 69:1338–1350.

[37] Robertson, G.P., Klingensmith, K. M., Klug, M. J., Paul, E. A., Crum, J. R., Ellis, B. G. 1997. Soil resources, microbial activity, and primary production across an agricultural ecosystem. Ecol. Appl. 7:158-170.

[38] Han F, Zheng J., Hu W., Du F. and Zhang X. 2010. Spatial variability and distribution of soil nutrients in catchments of the loess plateau in China. Acta Agricultural Scandinavica, Section B - Plant Soil Science 60: 1651-1913.

ISSN 2072-3875