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Development of B horizon in relation to Morphological characterization and soil uniformity of some soil of northern of Iraq

KEY WORDS:

Soil uniformity, Pedons, B horizon, VCS, Mosul

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ABSTRACT

The aim of the study to estimate soil uniformity and development using B horizon, Three pedons were selected within Nineveh Governorate (Rashedyia, Talafar, and Telkaif), The morphological description was carried out according to the principles followed in soil survey staff, (2014), then each pedon was divided into depths and soil samples were taken from these depths to be transferred in to laboratory for physical and chemical analysis, also some of sand particles separated by different size of sieves. The results showed an increase in sand particles values downward to the third depth and then decreased again in the fourth depth in most study sites. A parallel curve was reached at Talafar 's location within the deepest except for the fifth depth, which showed an intersection in the size of the very coarse sand (VCS), which gave a lower proportion of the rest of the depths, due to the fact that the sampling was taken advantage of the grazing area and there was no equal movement of that size between the depths, albeit slight. The values of the ratio of fine sand to the total sand showed that they were relatively lower than the values of the ratio of fine sand to coarse sand for all locations, its rates ranged (0.41 - 0.83), the standard deviation values from the arithmetic mean were less than 21% in all locations except the surface layer at Telkaif, which amounted to (30.61%).

INTRODUCTION

The soils are a basic economic resource that have a variety of uses, foremost of which are agricultural uses, which is one of the tasks of soil management. Soil management will not be able to perform its function unless its efforts begin by first knowing the existing types of soils in the geographical area. The survey and classification of soils undertakes the tasks of diagnosing these soils and their descriptions. The parent material is one of the important of soil forming factors, and it is defined by Jenny as the soil system at the beginning of its formation, i.e. when the time was zero. It is the basic structure of the soil before the beginning of its interaction with the environment and its impact on the factors and processes of soil formation Jenny, (1961).

When studying the development of any soil, it is necessary to identify the parent material from which the soil was formed, as once the parent material is identified and its components and characteristics are studied, it is possible to determine the pedogenic changes that occur in the characteristics of the soil formed from it. Therefore, the homogeneity of the pedogenic parent

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material is studied on the basis of estimating the pedogenic changes that occur in the soil pedon (Tsai and Chen, 2000).

The main objective of this study is to determine the homogeneity of each parent material with its horizons for some selected soils in Nineveh Governorate.

Al-Akedi, (1986) defined the parent material as “a group of minerals with a certain texture resulting from the weathering process of different rocks, and that they are not soil, but the state of the soil before the start of the processes and factors of soil formation from which the soil is expected to be and refers to horizon C. Brady, (1974) has classified the parent materials of sedimentary soils based on the diversity of the carrier factor as well as the sedimentation environment. The term Alluvial Soil is used by pedologists to refer to newly formed soils and is characterized by stratification and weak development. While the term is used by geologists and geographers to refer to the materials of the Halusin period (Buringh,1960). Al-Jubouri, (2001) mentioned, during his study of the riverine flats in the Balad region, the variation in the proportions of the soil separations of these flats, and attributed this to the effect of the nature of the parent material within the flats of Al-Mahdi, Al-Mu’tasim and Al-Mutawakil. The similarity of the main source of the parent materials for the mentioned flats was concluded and through the similarity of the nature of their mineral composition. Al-Mashhadani, (1994) noted that the particle size distribution and homogeneity degree showed a sharp diversity in the process of Soil Series Classification due to the diversity of the parent materials within their physiographic units representing the shape of Landscape. The degree of soil pedon development is often used as a scale for the amount of changes that occur in parent material, but it is very useful to subject all the values of soil properties to a quantitative scale by measuring the changes and developments that occurred in soil horizons, and these differ in the degree of development from one place to another according to the different factors of soil formation.

Jenny, (1994) indicated that the use of the ratio between fine sand/total sand gives a clear evidence of the homogeneity of the original material when studying three soils in Canada through the stability of this ratio in all soil horizons, as Schaetzl et. al., (2006) obtained the same conclusion when studying a number of soils in America. **The aim of the study is to estimate the uniformity among the each pedon horizons with the parent material and development of B horizon.**

METHODS AND MATERIALS

STUDY AREA: The study sites were chosen to include the agricultural regions (Talafar, Rashedyia, Telkaif) with flat topography to undulating, is located between longitudes (42º24′33.44″E - 43º13′34.37″E) and latitudes (36º32′04.63″N-36º12′22.28″N), three pedons have been chosen to study the Horizons uniformity with parent material and soil development. The common use of the crops land in the study areas are wheat, barley, and some vegetable crops spatially in Rashedyia region fig (1), Table (1).

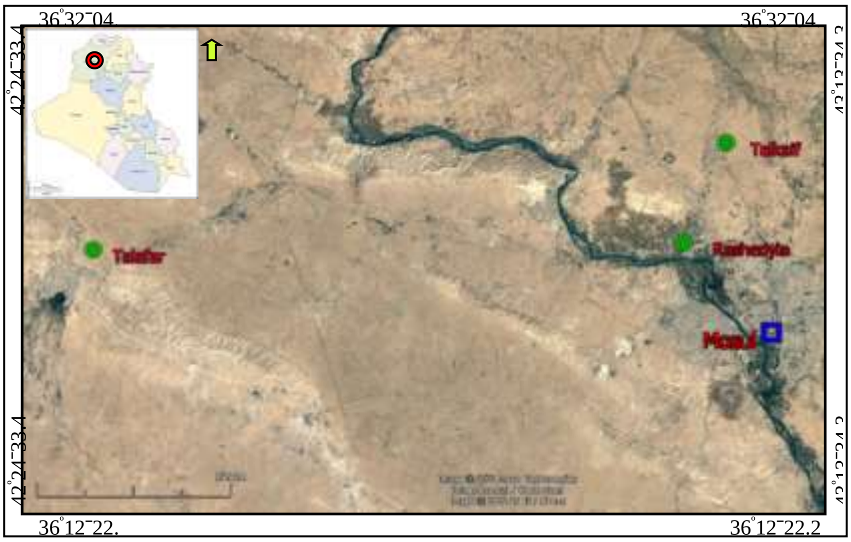

Fig (1): study map

Table (1): Selected locations for the study

no	locations	Sampling date	Latitudes N	Longitudes E
1	Talafar	12/10/2019	36º24¯12.54=	40º28¯40.05=
2	Telkaif	16/10/2019	36º29¯46.12=	43º7¯32.86=
3	Rashedyia	14/10/2019	36º24¯30.01=	43º4¯58.19=

CLIMATE DATA: the rainfall circumstances in the study area are changed from year to year and divided in to two periods over the year, Figure (2) showing monthly precipitation in (2000-2019) of Nineveh, (Agrometeorological Station in Mosul/ Iraqi Agrometeorological Center network (Agromet.gov.iq)

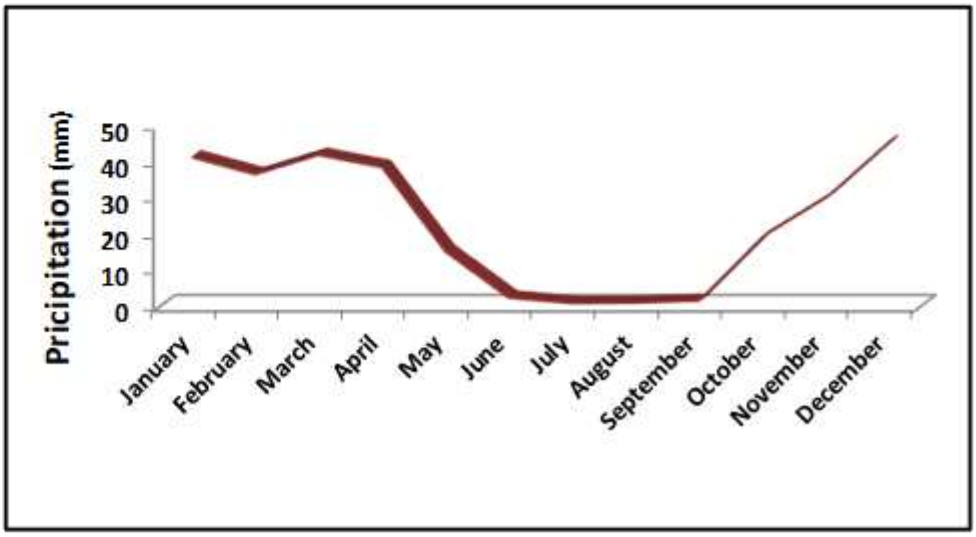

Figure (2): Monthly precipitation average in (2000-2019)

source: Agromet.gov.iq

FIELD WORK: Three soil pedons have been selected, one pedon for each location, and then every soil profile was divided into horizons depending on some morphological characteristics such as (soil color in the dry and wet conditions, Soil texture, soil structure, soil consistency, the accumulation of calcium carbonate in the depths, the spread or presence of plant roots and the boundaries between horizons), according to Wang and Arnold, (1973), then it was described morphologically according to Soil Survey Staff, (2014), soil samples were collected from the specified depths in order to conduct laboratory analysis on them,

LABORATORY METHODS: Soil samples (about 1 kg of soil) were collected from each horizon of the selected pedons, and then transported to the laboratory, which was airily dried then hammering with a wooden mallet in order to dismantle them, for research purposes. Soil Reaction (pH), Electrical Conductivity (Ec) according to Jackson (1976), Organic Matter (OM) using the Diphenylamine index according to (Tandon, 1999) and total Calcium Carbonate $CaCO_3$ as described by Hesse, (1971). Particle Size Distributions are determined using the hydrometer method described in (Gee and Bauder, 1986), Moisture Content (MC) as (Hesse, 1971), and Bulk Density according to Black's method mentioned in Page et al., (1982).

CRITERIA OF PARENT MATERIAL HOMOGENEITY: 500 gm of dry soil was taken pneumatically for each sample, and the sand was separated from the soil particles by decantation method (Gee and Bauder 1986) , Calcon (5%) was added to it with shaking for 15 minutes. The samples were passed through a group of sieves that are (2 mm) for very coarse sand, (1 mm) for coarse sand, (0.5 mm) for medium sand, (0.10 mm) for fine sand, and (0.05 mm) for very fine sand, respectively according to USDA systems. Then the weights of each separated were calculated individually and then The percentage of dry weight of the soil was calculated as in the equation:

$$\text{Sand fraction} = \frac{\text{weight of the fraction}}{\text{Weight of total dry soil}} \times 100 \text{ ------------------------ (1)}$$

Soil homogeneity was calculated at each pedon based on the calculations of the fine sand particle ratio (100-50 µm) to the total sand ratio (2mm-50 µm) according to Barshad, (1969) that he mentioned that The method of volume distribution for non-clay particles (sand) was used as it is not affected much by soil formation factors and processes, and it forms most of the minerals that make up the separations of non-clay soils. From materials of sedimentary origin. Relying on what was indicated by Barshad (1969) and Beshay and Sallam (1995) that fine sand separations are immobile and are little affected by soil formation processes, the ratio of very fine sand separations (0.05 - 0.1 mm) to total sand (2 - 0.05 mm) was chosen.) and fine sand (0.050-0.25 mm) to total sand (0.050-2 mm) for each of the horizons forming the study peduncles in order to identify the homogeneity of the parent material and its distribution pattern throughout the soil body. The ratios between soil separations were used as important criteria by many researchers in order to Determining the homogeneity of its parent material

. The percentages between fine sand and total sand, as well as fine sand and coarse sand were calculated in order to determine the homogeneity of parent material under the current study within (21%) as in the equation: $21\% = \frac{X^{-} - X}{X^{-}} \times 100$------------------------ (2)

Cumulative curve for the sand fractions was drawn as showing in fig. (1,2,3)
whereas
X^{-} = Percentage rate of fractions in all horizons.
X = Percentage of fraction per each depth

RESULTS AND DISCUSSION

Morphological features of soil pedons: Different morphological features were present in the research region, according to a field description. Topography, land use, and microclimate definitely had an impact in all of this. which all determine how strongly pedogenic and geomorphological processes affect the formation and development the soil. The results indicated that all of the research pedons featured master horizons (A, B, and C), despite the fact that they were all located in the same study region under semi-moist conditions (Fig. ?)These results were in line with previous finding by Ozsoy and Aksoy,(2012).

Soil color: The wave length value (Hue) for all pedons ranged from 7.5 to 10, with the exception of the 3^{ed} horizon of Rashedyia pedon, which has wave length value 5YR. While the dry case's value for the color intensity in pedons was equal to (7, 6, 5,3),the color intensity value decreased in sub-surface horizons due to a decrease in the content of organic matter or an increase in calcium carbonate. For the majority of profiles in both dry and wet instances, as well as for surface and subsurface horizons, the purity color value (Chroma) ranged between (3, 4, 6),

Horizons thickness: The results showed that the thickness of surface horizons varied based on the physiographic position of the pedon and pedogenic and geomorphological processes, notably topography and land use, had a significant impact. The horizon A at pedons (1 and 2) was 15 cm thick, whereas the horizon A at pedon 3 was 25 cm thick. This thickness is the result of prior deposition on the pedon's surface layer, a When this pedon was unearthed amid a grove of plants as shown in Table (2,3,4)This is compatible with the horizon differentiation, thickness, and structural data given by Ali et al. (2020).

The three pedons' surface horizons' soil consistency was showing that it was hard in the dry condition but harder and harder in the other strata, the soil consistency in the wet situation was extremely sticky and plastic in sub-surface strata. These results were in agreement with those of Azeez and Muhaimeed (2016) and Muhaimeed et al. (2018), who discovered that increases in clay concentration led to variations in soil consistency between hard and soft under dry and damp circumstances.

Pedons' soil structure ranged from being angular or sub-angular blocky to being very fine to very coarse in texture. All surface horizons exhibited crumb and blocky or granular features.

Table (2): Telkaif pedon

Depth (cm)	Morphological description
0 -15	Light Yellowish brown 10 YR 6/4 (d) , Dark brown 7.5YR 3/4 (m) , Clay Loam, Granular , hard (dry) , plastic (wet) , nodules of calcium carbonate, fibrous roots small, Abrupt boundary.
15 - 40	Pale brown 10 YR 6/3 (d), Dark brown 7.5 YR 4/4 (m), Silty Clay Loam, Structure is regular mass of rough size, low hardness when dry and sticky when it is wet, nodules of calcium carbonate , Fibrous small roots , Abrupt boundary
40 - 60	Very Pale brown 10 YR 7/4 (d), Dark brown 7.5 YR 4/4 (m) - Clay - regular columnar structure of crumb - firm when dry and sticky in wet condition - presence of calcium carbonate, fibrous roots are absent – Gradual boundary
60-100	Very Pale brown 10 YR 7/4 (d), Dark brown 7.5YR 3/4 (m) – Clay - medium sized, blocky structure with uniform angles, firm when dry and very sticky when wet, presence of calcium carbonate in the form of knots, The absence of fibrous roots.

Table (3): Talafar pedon

Depth (cm)	Morphological description
0 -15	Pale brown 10 YR 6/3 (d), Dark brown 10 YR 4/3 (m) - Silty Clay Loam – Texture are Blocky uniform with a fine volume - little hard when dry and plastic when wet, presence of calcium carbonate - Fibrous roots and organisms of roots, Broken boundaries.
15 - 45	Brown 10 YR 5/3 (d), Dark brown 10 YR 3/3 (m) - Silty Clay - Structure of a uniform blocky of medium size - firm when dry and sticky when moist, presence of calcium carbonate - fibrous roots -Definitive (Abrupt) boundaries
45 - 70	Brown10 YR 5/3 (d), Dark brown 10 YR 4/3 (m) – Clayey - uniform blocky with large angles - Solid when it is dry and sticky when it is moist - Aggregate of calcium carbonate as nodules - No fibrous roots, Gradient Boundary
70 -100	Pale brown 10 YR 6/3 (d), Dark brown 10 YR 4/3 (m) - Silty Clay, Columnar irregular structure of medium size - little hard when dry and sticky when moist, carbonate is normally collected Nodules - No fibrous roots.

Table (4): Rashedyia pedon

Depth (cm)	Morphological description
0 - 25	Dark brown 10 YR 3/3 (d), Dark brown Yellowish 10 YR 3/6 (m)- Silty Clay- Granular with fine size texture - hard when dry and plastic when moist, Nodules of calcium carbonate, Fibrous roots - Abrupt Boundary.
25 - 55	Brown 7.5 YR 5/4 (d) - Brown 7.5 YR 5/4 (m) – Clay - Lumpy with regular angles of medium size structure - Solid when dry, less plastic when moist - presence of calcium carbonate - Fibrous roots - Abrupt Boundary
55 - 80	Light brown 7.5 YR 6/4 (d), Yellowish red 5 YR 4/6 (m) - Clay – sub-angular medium size - little hard when dry and sticky when moist - presence of calcium carbonate - Fibrous roots with tunnels for organisms and roots, Abrupt Boundary
80 -110	pink 7.5 YR 7/4 (d), Strong brown 7.5 YR 5/6 (m) - Clayey - Columnar with a coarse size - low in hardness when it is dry and very sticky when it is moist - the presence of calcium carbonate in the form of knots - Roots are absence.

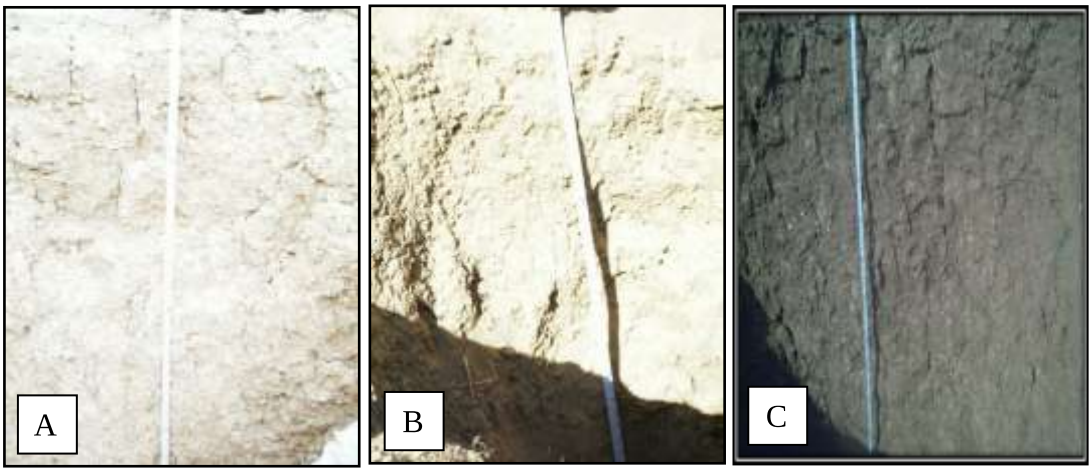

Figure (3): The soil profiles for Telkaif (A), Talafar (B) and Rashedyia (C) pedon

Chemical Properties: The pH value of the soil surface ranged between (7.2-7.9) as shown in Table (5), . The high value of pH in the study area is due to the high percentage of calcium carbonate, The value of Calcium Carbonate is between (258-448) g Kg^{-1}. Soil texture was Clay Loam (Cl) for all horizons in Telkaif pedon and was same for Talafat pedon except surface horizon was Loam (L), while was Sand Loam and Loam (SL and L) for Rashedyia , Organic Matter ranged between (6.12 – 13.86) g kg^{-1} . result noted only pedon Rashedyia has B_{k1} and B_{k2}, but other pedon have only B_k

Table (5) Physical and chemical properties of soil study samples

location	Depth (cm)	Horizon	Sand	Silt	Clay	Texture_Class	BD	M.C	EC	OM	CaCO$_3$
			g kg^{-1}				*Mg* m^{-3}	%		*g kg^{-1}*	
Telkaif	0 -15	A_p	170.1	38.91	44.08	Cl	1.31	06.38	0.78	8.94	302.0
	15-40	B_k	207.0	336.8	456.2	Cl	1.36	14.34	0.59	7.73	332.5
	60 - 95	C_{k1}	186.8	322.1	491.1	Cl	1.40	12.42	0.41	6.18	360.0
	95 -120	C_{k2}	189.3	315.7	495.0	Cl	1.41	10.73	0.40	6.12	375.0
Talafar	0 -15	A_p	474.4	298.5	227.1	L	1.32	11.44	1.21	9.10	251.0
	15-45	B_{tk}	178.2	328.5	493.3	Cl	1.34	17.25	0.50	7.91	342.0
	45 - 70	C_{k1}	293.0	213.0	494.0	Cl	1.38	17.46	0.39	6.82	344.0
	70 -100	C_{k2}	144.0	263.5	592.5	Cl	1.38	17.82	0.39	6.30	353.0
Rashedyia	0 - 25	A_p	483.0	324.0	193.0	L	1.43	20.44	0.48	13.86	260.0
	25 - 55	B_{k1}	515.5	296.0	188.5	L	1.45	20.45	0.37	08.10	284.0
	55 - 80	C_{k1}	556.5	279.5	164.0	SL	1.46	14.12	0.33	06.86	270.0
	80 -110	C_{k2}	564.0	261.0	175.0	SL	1.46	13.64	0.23	06.46	281.0

Cumulative Aggregate size distribution of sand particles:

Table (6) shows the percentages of the fraction's distribution of the non-clay particles, from which the horizon cumulative curves were drawn of the studied pedons.

Table (6): Percentage of size distribution of non-clay particles in the studied soils

locations	Depth (cm)	Horizon	V.C.S%	C.S%	M.S%	F.S%	%V.F.S
Telkaif	0-15	A_p	1.30	1.75	1.53	3.56	4.57
	15-40	B_k	3.77	3.46	3.05	3.84	4.28
	40-60	C_{k1}	3.47	3.38	3.21	3.61	3.50
	60-100	C_{k2}	3.39	3.25	3.84	3.96	3.81
Talafar	0-15	A_p	0.64	1.22	1.95	3.70	3.48
	15-45	B_{tk}	1.30	2.34	2.75	4.52	3.83
	45 - 70	C_{k1}	1.05	1.86	1.88	3.82	5.57
	70 -100	C_{k2}	1.03	1.11	2.36	4.56	5.69
Rashedyia	0-25	A_p	1.18	2.27	3.21	9.29	10.36
	25 - 55	B_{k1}	1.22	2.47	3.52	10.50	12.32
	55-80	C_{k1}	1.52	2.32	5.73	11.46	13.29
	80 -110	C_{k2}	1.73	2.44	4.88	10.21	12.05

Table (7) of comparing the five horizon values for sand fractions with each other and shows that there is an increase in the fraction values downward to the third depth and then decreases again in the fourth depth in most study sites. While we note in the Rashedyia site that the sand separators increased downwards to bottom for the all size ,

Table (7): cumulative values of the sand particles in pedons of studied soils

location	Depth (cm)	1	2	3	4	5
Telkaif	0 -15	1.30	3.05	4.58	8.14	12.71
	15 - 40	3.77	7.23	10.28	14.12	18.40
	40 - 60	3.47	6.85	10.06	13.67	17.17
	60-100	3.39	6.64	10.48	14.44	18.25
Talafar	0 -15	0.64	1.86	3.81	7.51	10.99
	15-45	1.30	3.64	6.39	10.91	14.74
	45 - 70	1.05	2.91	4.79	8.61	14.18
	70 -100	1.03	2.14	4.50	9.06	14.75
Rashedyia	0 - 25	1.18	3.45	6.66	15.95	26.31
	25 - 55	1.22	3.69	7.21	17.71	30.03
	55 - 80	1.52	3.84	9.57	21.03	34.32
	80 -110	1.73	4.17	9.05	19.26	31.31

Parent material homogeneity criteria (ratio of fine sand to coarse sand and fine sand to total sand)

The results in figures (1,2 and 3) showed that there is a homogeneity of Parent Material with the (horizon) that constituting soil pedon in order to parallel the curves in most of the study sites, and this may be due to the fact that the parent materials of that area are mostly due to deposits of same parent regardless of the cumulative values of each depth, which are due to the nature of agricultural exploitation of each site and the conditions surrounding the area (pedagoge) as well as, and influence of soil formation factors and processes that have a clear impact on the distribution of materials, particularly with regard to the transfer and deposition of geological components, as well as the difference in the intensity of soil weathering processes (Brewer, 1976). However, it is noted from Figure (2) that the Talafar site parallels the curves within the deepest, except for the fourth horizon, which showed an intersection in the volume of very coarse sand (VCS), as it gave a lower percentage than the rest of the depths, due to the fact that the sampling was that the area was exploited for grazing and there wasn't equal transport of that size between the depths, although slight.

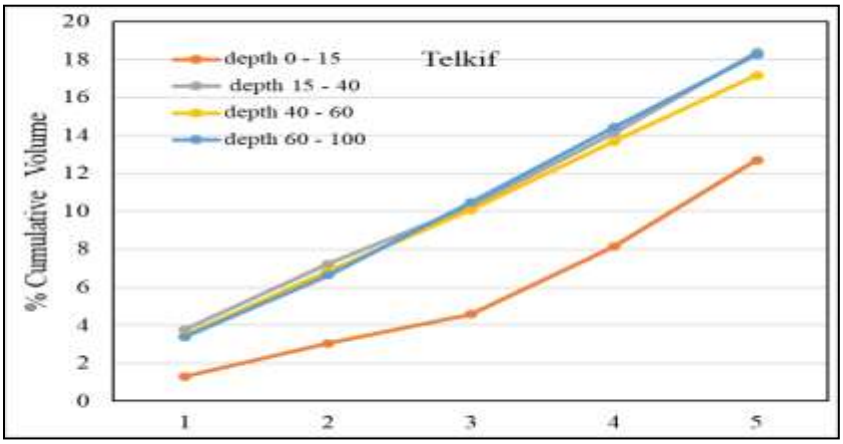

Figure (1): Cumulative percentage of sand fractions in Telkef pedon

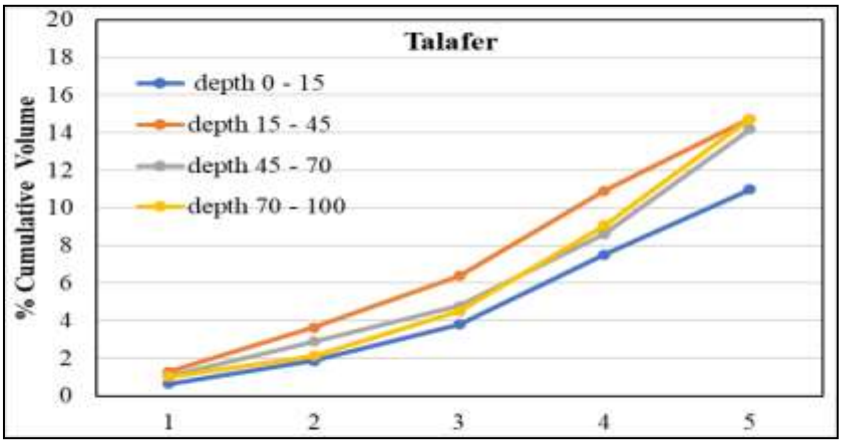

Figure (2): Cumulative percentage of sand fractions in Talafar pedon

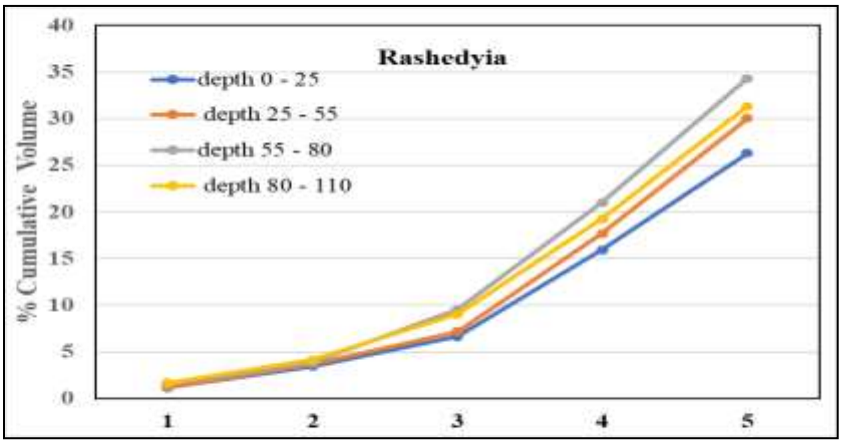

Figure (3) Cumulative percentage of sand fractions in Rashedyia pedon

Table (8) shows the fine sand ratio (very fine sand + fine sand) / coarse sand (very coarse sand + coarse sand) and fine sand (very fine sand + fine sand) / total sand, that there is an increase in fine sand to the Coarse sand ratio in the surface and subsurface layer at all sites. The values of the fine sand/total sand showed that it was relatively less than from the values of the previous ratio for all sites, which is rates ranged (0.41 - 0.83), and the values of the standard deviation from the arithmetic mean were less than 21% in all sites except for the surface layer at Telkef pedon, which amounted to (30.61%). These results are consistent with homogeneity curves with the reasons mentioned, which indicates the possibility of using this last ratio as a better method in determining the homogeneity of the soil parent material, and this is consistent with what was mentioned by Adams and Evans, (1975)

Table (8): Standard deviation of fine sand over coarse sand and fine sand from total sand

location	Depth (cm)	Fine sand (V.F.S + F.S) / coarse sand (V.C.S + C.S)	21%	Fine sand (V.F.S + F.S) / Total sand	21%
Telkaif	0 -15	2.66	78.52	0.64	30.61
	15 - 40	1.12	24.83	0.44	8.34
	40 - 60	1.04	30.20	0.41	14.58
	60-100	1.17	21.47	0.42	12.50
	Average	1.49		0.48	
Talafar	0 -10	3.86	9.04	0.65	1.56
	10 - 20	2.29	35.31	0.56	12.50
	45 - 70	3.23	8.75	0.66	3.12
	70 -100	4.79	35.31	0.69	7.81
	Average	3.54		0.64	
Rashedyia	0 - 25	5.77	2.69	0.75	1.35
	25 - 55	6.18	4.21	0.76	2.70
	55 - 80	6.44	8.60	0.72	2.70
	80 -110	5.34	9.95	0.71	4.05
	Average	5.93		0.74	

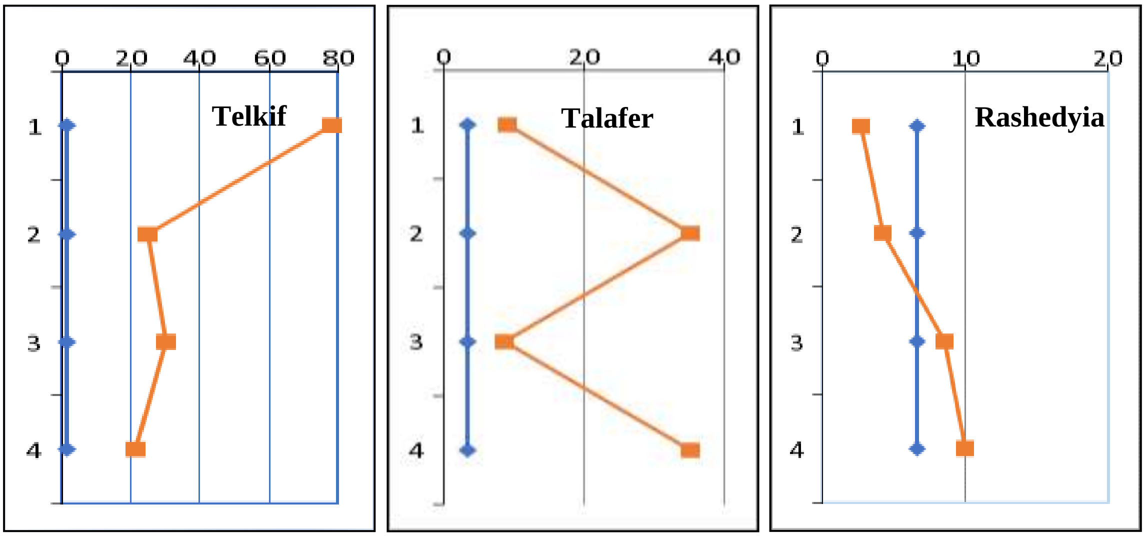

Figure (4): Standard deviation of fine sand (V.F.S + F.S) / coarse sand (V.C.S + C.S) for studied pedons

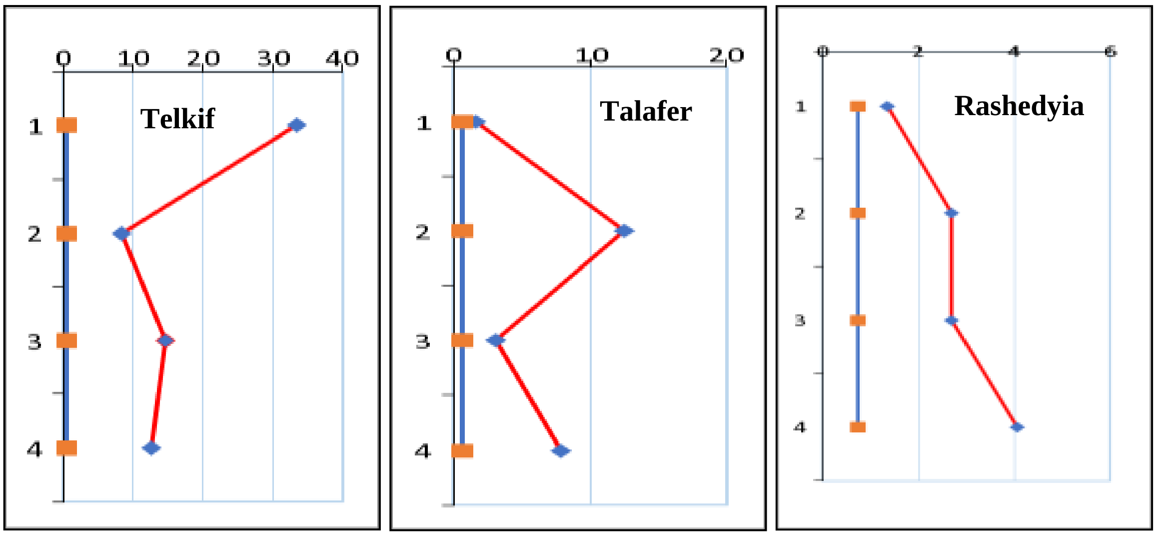

Figure (5): Standard deviation of fine sand (V.F.S + F.S) / total sand in the studied pedons

CONCLUSIONS

1- The study concluded that the ratio (VFS + FS) to the total sand is the best way to determine the homogeneity of the soil parent material with the horizons in the study area according to this ratio, in order to parallel the aggregative curves drawn for most of the study sites.

2- This study indicates the homogeneity of the parent material of the study- pedons to 70 cm depth and the absence of buried soil.

RECOMMENDATIONS

1 - Expansion and increase in the number of samples

2 - Draw a map of each of the study's codes, the pedons that will be studied later, and determine the homogeneity of the parent materials of these pedons.

3- We recommend studying the buried soil case in these homogeneous sites, and identifying the ancient vegetative cover (ancient climate).

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مقياس تطور الافق B بدلالة التوصيف المورفولوجي ومدى تجانس بعض الترب شمالي العراق

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الخلاصة

هدفت الدراسة الى استخدام الافق B كمؤشر لتطور وتجانس مادة الأصل لبعض الترب في محافظة نينوى, اختيرت ثلاثة بيدونات ضمن محافظة نينوى (الرشيدية، تلعفر، تلكيف). تم إجراء الوصف المورفولوجي وفقاً للأسس المتبعة لدليل مسح التربة الأمريكي, (2014)، ثم قسمت كل بيدون إلى أعماق وأخذت نماذج التربة منها ليتم نقلها إلى المختبر لإجراء التحليل الفيزيائية والكيميائية عليها، وكذلك تم فصل مفصولات الرمل بالاعتماد على المناخل. أظهرت النتائج زيادة في قيم مفصولات الرمل حتى العمق الثالث ثم انخفضت مرة أخرى في العمق الرابع في معظم مواقع الدراسة. تم الحصول على منحنى موازي في موقع تلعفر ضمن الأعمق باستثناء العمق الرابع والذي أظهر تقاطعًا في حجم الرمال شديدة الخشونة (VCS) ، مما أعطى نسبة أقل من بقية الأعماق ، بسبب حقيقة أن أخذ العينات قد تم استغلاله من منطقة الرعي ولم تكن هناك حركة متساوية بهذا الحجم بين الأعماق، وإن كانت طفيفة. أظهرت قيم نسبة الرمل الناعم إلى الرمل الكلي أنها أقل نسبيًا من قيم نسبة الرمل الناعم إلى الرمل الخشن لجميع المواقع ، حيث تراوحت معدلاتها (0.41 - 0.83) ، وقيم الانحراف المعياري عن الحساب. كان المتوسط أقل من 21٪ في جميع المواقع ما عدا الطبقة السطحية في تلكيف والتي بلغت (30.61٪).