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Effect of Physiographic Unit on Sand Mineral Distribution in Different Regions From Mesopotamia Plain

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Abstract: *A field study was carried out in the year 2019 to find out the effect of the physiographic location on the distribution of sand minerals and some soil characteristics in the area extending from the left side of the Euphrates River and to the end of the site of the Great Musayyib Project and with coordinates 33°.32, 32°.44 N, 44°.22 and 44°.54 E, four secondary physiological units were selected was river levee represented by the MW3 series, irrigation levee represented by MW5 soil series, the river basin represented by DM97 soil series, and the depression unit represented by MF11 soil series, pedon of soil series revealed and described morphology and obtained samples from them for the of laboratory analysis, the results indicated that all soil series represent sedimentary soils with materials of river origin transported and have different texture type dependent on the physiographic location, sand particle dominate at the series of river levee. In contrast, clay particles dominate the depression unit. Mineral analysis of fine sand particles showed the dominant quartz minerals, then calcite and feldspar for light sand minerals. In contrast, heavy sand minerals appear to dominate opaque minerals, pyroxene, and amphibole. The results of weathering index showed low values to indicate a low rate of weathering in the soil.*

Keywords: *Mesoptamia plain; mineral distribution; physiographic unit.*

1. INTRODUCTION

Iraqi sedimentary plain is one of the physiographic divisions of the surface of the soil of Iraq. It is characterized by its lack of general slope. Its origin dates back to the Pleistocene era and is interspersed with various ranges of secondary physiographic units, including the river levee unit, the unit of irrigation levee , the unit of the river basins, and the dipression basins unit. The rivers levee are natural phenomena in the areas of flood plains and their soils are rich in nutrients, and most of their refinement is silt and are located behind the sources of sediment transport (main rivers). There is also a unit of river basins and it is characterized by being lower in relation to the shoulders of rivers, as well as having the advantage of containing fine texture particles formed due to the sediments that the river deposited far from its streams, and the middle of this range is characterized by a great expansion with a gradual slope as we head towards the south, and this zone is characterized by the fact that the groundwater is near the surface [1].

Issa and Al-Shaikhly [2] indicated that the study of soil minerals is of great importance in understanding soil chemistry because minerals, especially colloidal ones, are very important for cation exchange, in addition to chemical weathering that liberates plant nutrients.

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Salih and Muhaimid [3] indicate in their study of the nature of the mineral composition of some series of river levee in the middle of the Iraqi Mesopotamia plain, that opaque minerals are distributed irregularly in the soil horizons and reflect the influence of geomorphological processes, especially the sedimentation processes that took place in the region. Heavy sand fraction minerals showed the predominance of Amphibole mineral while Quartz in the fine sand joint due to its resistance to weathering processes and due to its strong crystalline building bonds as well as its inheritance from the parent material. [4] indicate that the Iraqi Mesopotamia plain is one of the main components of the Iraqi surface. Its length in the horizontal dimension is about 650 km and its average width is about 135 km., and the soils formed from the rivers sediment inherited from igneous and sedimentary rocks obtained by weathering processes in the areas of the two rivers and transferred and then deposited in these areas when the momentum of the river decreased from the transfer of its materials, and the sediments that existed near the river are called river levee, while the sediments that settled in a place farther away are called river basins. [5] indicate that the nature of the mineral composition and the formal characteristics of the finer sand fraction minutes differ according to the difference in the depth of the soil, the particles present in the surface layers of soils were of dark colors, which may be due to the presence of organic matter in them, while some of the particles appear yellow, which returns to iron oxides, as for the minerals in the depths of the soil, they are in a light color, which returns to the color of the original material, as there is a predominance of quartz minerals within the minerals of light sand, which is due to the nature of the original material, while the lady was of the opaque minerals within the minerals of heavy sand [6] in her study of the mineral properties and heavy elements of the soils of the Iraqi mesopotamia plain within the two sites of Wasit and Maysan governorates indicated that the mineral composition of the light sand between the rock fragments, followed by the quartz minerals, then flint, chert, feldspar, while the minerals of heavy sand were the dominance of minerals Opaque and low values of strualite, kyanite, rutile and tourmaline minerals with weak mineral weathering processes due to lower values of zircon and tourmaline compared to higher content of pyroxenes and amphiboles.

2. MATERIALS AND METHODS

The study area is located in Babylon governorate between the Tigris and Euphrates rivers and on the left bank of the Euphrates River 2 km from the dam of Al-Hindiya and ends at the borders of the Mussiab project, about 80 km east of the Euphrates River and within the geographical coordinates between longitudes (44°.22 and 44°.54 E) and two latitude 33°.32 and 32°.44 N), which is part of the sediments of the flood plain known as the Iraqi mesopotamia Plain [7] . 4 sites representing the physiographic units of the region were selected (river leeve , irrigation levee, river basins, and dippression) and on the right side of the sediment conveyor source (the Euphrates River), in order to determine the mineral characteristics of the series representing each physiographic site, as the MW3 series represented the river levee unit , MW5 series represent Irrigation levee unit, DM97 series represent river basins unit, while MF11 series represented the dipression unit, to be studied and using the GPS system with the UTM coordinate system, the locations of the structures were determined for the studied area, then the soil structures were revealed, the morphology was described and soil samples were obtained from the horizons according to [8] , then the soil samples were dried, milled and passed through a sieve with a diameter of 2 mm holes for the purpose of measuring soil characteristics that represent some of the physical and chemical properties of the soil, which included the size distribution of soil particles, soil (pH) using a pH meter , and electrical conductivity. (Ece) in a saturated soil paste using the electrical Conductivity bridge and the Cation

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exchange capacity (CEC) was obtained by using ammonium acetate 1N NH_4OAc at (pH = 7.0) , the soil content of calcium carbonate minerals ($CaCO_3$) using acid (HCl 1N) and titrate with NaOH (1N) , and the soil content of calcium sulfate minerals ($CaSO_4.2H_2O$) By precipitation with acetone , soil organic matter content (OM) by the method of wet digestion [9], [10] .

The mineral analysis included removing the salts from the samples by washing them with distilled water three times, then removing the calcium carbonate using the corrected sodium acetate with a reaction pH 5 [11] and the organic matter was removed using a 14% sodium hypochlorite solution [12]. The removal of free oxides by NA-citrate-bicarbonate-dithionite method and according to the method of [13]. Then the separation and fractionation process was performed for more than 50 microns by wet sieving method .The sand minerals (53-100 microns) and their light and heavy types were separated by using a bromoform solution of a specific weight of 2.89 for the purpose of preparing slides and examining the materials according to their optical properties according to the method mentioned in [14] and by using the polarized microscope, then determining the percentage of each mineral within the field of vision.

3. RESULTS AND DISCUSSION

3.1. Morphology of soil series

The detection of soil types, their locations and areas, and their distribution in the pedological perspective, represents the scientific basis for soil surveying operations, as well as determining their best uses [15] . On this basis, the characteristics were determined for each unit of soil units in the study area distributed among 4 pedons, as well as the general morphological characterization of the soil surface and the extent of the spread of natural vegetation in relation to fallow soils and salinized ones in comparison with irrigated soils used for agricultural purposes that are characterized as higher fertility and less degraded than the previous one. The area is a sedimentary soil that varies in its tissues according to the different stages of sedimentation factors as well as the nature of the transport medium, which leads to a state of stratification in it, as it is an inherent characteristic of it and is known pedologically as heterogeneity in the soil separations [16] , and the most prominent chemical characteristics that can be Its morphological description is the presence of pale-colored complexes, most of which are due to calcium carbonate compounds, thus it appears that the calcification process is highly dominant over all other pedogenic processes, and the soil origin material is of the Calcareous Alluvium river sediment type. The local conditions of the study area are represented by the dry climate, the weakness of the natural vegetation cover and the dependence on the cultivation of annual plants with the transfer of saline compounds from the leftover soils to the cultivated soils as well as the predominance of calcium carbonate did not lead to the development of a shallow diagnostic horizon in itself, and that the dominant horizon is the Ochric horizon. It has the advantage of being rudimentary in development, pale in color, with the exception of soils treated with organic materials or subject to continuous cultivation, which may tend towards a dark brown color, as well as the complete absence of the diagnostic horizons developed below the surface. [17], Table (1) indicates the most important morphological features of the studied soil series.

A) MW3 series

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A series of sedimentary soils that arose from newly formed sediments of river origin materials transported to the Euphrates River and are located within the physiographic unit of river cords with coordinates 32 ° 44′47″ N 44 ° 22′34.02″ East and are classified as Typic Torrifluvents, the soil body consists of one classification layer with a coarse texture. Its internal drainage grade is good and the slope is about 1-2%. The color of the upper horizon is light brown in the dry state and brown in the wet state and the soil texture of the surface horizon is a sandy clay mixture SCL The structure is granular with rounded edges weak to moderate. The mottling appears with a depth of more than 137 cm and the depth of the ground water at 180 cm.

B) MW5 series

A series of sedimentary soils that formed from newly sediments of river origin materials transported to the Euphrates River and are located within the physiographic unit of the canals of irrigation leeve, with coordinates 32 ° 44′58″ N 44 ° 38′59″ E, and their classification is Typic Torrifluvents, the soil body consists of one classification layer with a medium rough texture. Its internal drainage grade is good and the slope is about 1-2%. The color of the upper horizon is light yellowish brown in the dry state and brown in the wet state. Soil texture of the surface horizon is a clay-silty mixture. Block construction with rounded rims is weak to medium. The spot appears with a depth of more than 110 cm, and the depth of the ground water is 165 cm.

C) DM97 series

A series of sedimentary soils that arose from sediments of transported river origin materials and are located within the physiographic unit of the river basins, with coordinates 32 ° 42′12 ° N 44 ° 47′05″ E and classified as Typic Torrifluvents, with medium textures for the upper horizons and soft for the deeper horizons within the classification section and the degree of natural drainage of it is medium and slope 1-2% and the thickness of the upper horizon is 28 cm, and the color becomes darker when the percentage of sand separating is reduced, the depth of mottling is at 75 cm from the soil surface and the depth of the ground water is at 145 cm. Soil salinity is medium to high and its strength increases in wet conditions and changes from fragile friable to cohesive Firm with increasing depth, the structure is granular for the upper horizons and masses with corners or rounded edges in the deep horizons, the organic matter is low .

D) MF11 series

A series of sedimentary soils formed from modern sediments transported by river from the Euphrates. They are located within the physiographic unit of the buried basins, with coordinates 32 ° 33″59″N 44 ° 4624قا″ E, and their classification is Typic Torrifluvents. The soil body consists of a single stratum layer with a fine-grained silty clay texture SiC. Its internal drainage class is imperfectly drained, as the spotting appears at a depth of (46) cm and the depth of the groundwater is at 85 cm. Its topography is flat, the slope is about (1-2%).

3.2. Soil texture and some soil chemical characteristics

The sequence of sedimentation processes and the succession of floods and the variation in intensity and momentum between turbulence and calm led to a gradually diversified deposition of the transported sedimentary materials. The textures of the series were alternated and varied, ranging from moderate to

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coarse and fine depending on the speed and distance traveled by the conveying water. In addition to the lack of slope, the shortness of its length, and the variation in the lengths of the transmission distances, it leads to the sedimentation of coarse joints first, then the deposition of the smaller particles, followed by the deposition of the suspended particles when the conveyor speed decreases. This explains the presence of heterogeneity of naturally occurring sediments and their containment of particles of various sizes [18].

Table 2 refers to the percentages of soil particles in the study pedons, as the sand content ranged from 162.8 $gm.kg^{-1}$ at the last horizon of the classification section of the MF11 series to 485.2 $gm.kg^{-1}$ at the surface horizon of the MW3 series. The increase and decrease in the content of this joint is affected by the nature of Sedimentation and physiographic location. So, it is noticed that the highest sand content was found in the soil series belonging to the physiographic location of the river levee unit in which coarse and medium-fine texture are spread. This is also reflected in the clay content. So, the increase in the clay content is at the expense of the decrease in the other sand particle, sand and silt. Here, we note that the highest content of clay particles was 426.8 $gm.kg^{-1}$ in the last horizon for the MF11 series, while the lowest content of it was in the last horizon, at 160.4 $gm.kg^{-1}$, at 160.4 $gm.kg^{-1}$, which belongs to the MW3 series.

Table 1. Some physico-chemical characteristics of soil series study

Soil Series	Horizons	Depth in cm.	Color		Texture class	Structure	Consistency				Boundary
			Dry	Moist			Dry	Moist	Wet		
									Stick.	Plastic.	
MW3 River Levee	A_p	0-27	10YR6/3	10YR5/3	SCL	1mg	dL	mvfr	wns	Wnp	as
	C_1	28-63	-	10YR5/3	SL	1msbk	ds	mfr	wns	Wnp	cs
	C_2	64-110	-	10YR4/3	SL	1msbk	ds	mfr	wss	Wnp	cs
	C_3	111-150	-	10YR4/3	SL	1msbk	dh	mfr	wss	Wnp	-
MW5 Irrigation Levee	A_p	0-27	10YR6/3	10YR4/3	SiL	1mg	dL	mvfr	wns	Wnp	as
	C_1	28-62	-	10YR5/3	SiL	1msbk	ds	mfr	wss	Wsp	cs
	C_2	63-104	-	10YR4/3	SiL	2msbk	ds	mfr	wss	Wsp	cs
	C_3	105-142	-	10YR4/6	SiL	2mabk	ds	mfr	wss	Wsp	-
DM97 River Basin	A_p	0-28	10YR5/3	10YR5/2	SiCL	3mg	dL	mfr	wss	Wsp	as
	C_1	29-65	-	10YR5/6	SiCL	2mabk	dh	mfr	ws	Wp	cs
	C_2	66-110	-	10YR3/3	SiC	2msbk	dh	Mfi	ws	Wvp	cs
	C_3	111-140	-	10YR3/4	SiC	2mabk	dh	Mfi	ws	Wvp	-
MF11 Dipression	A_p	0-29	10YR8/2	10YR3/3	SiC	2msbk	dh	mfr	wss	Wsp	as
	C_1	30-76	-	10YR5/3	SiC	3msbk	dh	Mfi	ws	Wp	cs
	C_2	77-112	-	10YR4/3	SiC	3msbk	dh	Mfi	ws	Wvp	cs
	C_3	113-140	-	10YR4/4	SiC	3mabk	dh	Mfi	ws	Wvp	-

The proportion of silt ranged from 208.7 $gm.kg^{-1}$ at the surface horizon of the MW3 series to 576.8 $gm.kg^{-1}$ at the subsurface horizon of the MW5 series. It is noted from the soils scattered in the study area that they were in various texture ranging from coarse, medium and fine. This is due to the nature of the vector and the sedimentation periods during which the soils were formed, in addition to the location of that soil on the biological perspective and the physiographic units it constitutes. This is what distinguishes sedimentary soils from the rest of the soils, as they have wide heterogeneity in soil textures, and that the

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soil texture, distribution and variability from one site to another contributes to knowing how the soil is formed, the nature of sedimentation and the factors affecting the formation of these tissues and their effect on the distribution of the sedimentation process pattern for the soils of the studied series and their effect on the distribution of soil minerals horizontally and vertically [19] .

The results of Table 2 show some of the chemical characteristics of the soil series studied in the Al-Mussaib greater project. Soil salinity values ranged from 2.1 ds.m^{-1} at the C3 horizon for the MW3 series to 23.5 at the surface horizon for the MF11 series with average of 8.82 ds.m^{-1} for the general. The horizons of the soils of the studied series, and the high salinity of soils in that series is due to the low physiographic location of them, which form transition zones between depressions and irrigation basins, and to the high percentage of clay and the activity of the capillary property that led to the accumulation of salty on the surface. The soil in it returns first to its high physiographic location, which constitutes the unity of rivers and irrigation channels, in addition to the fact that the soil tissue helps to wash more salts when water is available. The values of the CEC ranged from 14.2 to 23.1 Cmole charge. kg^{-1} and has an average charge of 17.68 Cmole.kg^{-1} for the general horizons of the studied soil series, as the high values of this characteristic are related to the clay content, as it was the highest value in the first horizon of the MF11 soil series that is characterized by the alluvial clay texture in the control section of that series. As for the low value, it was on the last horizon of the MW3 soil series, which is characterized by a coarse, sandy mixture in the control section of the same series. The reason is clear, as there is a direct relationship between the clay content and the exchange capacity of the positive ions [20]. As for the carbonate minerals values, they ranged between 210.7 - 339.2 gm.kg^{-1} with a rate of 248.09 gm.kg^{-1} in the general horizons of the studied soil series. This is what characterizes the calcareous sedimentary soils in the Iraqi sedimentary plain, as the percentage of carbonate minerals increases as a result of secondary sedimentation from the soil solution and their accumulation in the soil, as well as the fact that the soils from calcareous materials [21] . Gypsum did not show a high content in the soil, as its values ranged between 0.6 - 1.4 gm.kg^{-1} and average of 0.89 gm.kg^{-1} due to the increase in solubility of this compound as well as the cumulative preference of calcium carbonate compared to calcium sulfate [22] . The values of chemical properties such as salinity, organic matter and cation exchange capacity showed a clear decrease in their values with the depth of the soil, while the values of calcium carbonate and the degree of reaction with depth increased [23] . The characteristic of gypsum content in the soil did not show a clear trend in its values with depth due to the nature of the accumulation of these minerals with depth in soils of arid and semi-arid regions.

Table 2. Some physico-chemical characteristics of soil series study

Physio. unit	series	Depth cm	Soil particle gm.kg^{-1}			texture	Ece	CEC	CaCO3	CaSO4	O.M
			sand	silt	clay				gm.kg^{-1}		
River Levee	MW3	27-0	485.2	208.7	306.1	SCL	5.6	16.7	210.7	0.9	7.2
		63-28	414.2	385.5	200.3	L	3.8	15.1	225.9	1.4	5.6
		-64 110	426.9	412.7	160.4	L	2.1	14.2	275.2	1.1	4.7
Irrigation Levee	MW5	27-0	211.8	510.4	277.8	SiL	9.2	18.5	217.4	1.2	7.9
		62-28	197.9	576.8	225.3	SiL	5.6	16.6	237.6	0.7	6.3
		63- 104	232.1	509.3	258.6	SiL	3.1	15.1	251.8	0.7	3.8
River Basin	DM97	28-0	189.7	499.6	310.7	SiCL	14.7	19.7	228.7	0.8	9.3
		65-29	185.8	504.6	309.6	SiCL	11.9	18.1	241.8	0.7	7.6
		-66 110	168.2	413.3	418.5	SiC	5.6	20.2	267.0	0.6	5.1

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Dipression	MF11	29-0	183.5	405.6	410.9	SiC	23.5	23.1	227.6	1.3	13.6
		76-30	176.2	402.9	420.9	SiC	13.4	18.2	339.2	0.7	11.4
		-77 112	162.8	410.4	426.8	SiC	7.3	16.7	254.2	0.6	7.2

3.3. Light mineral of sand fraction

The results shown in Table 3 show that the percentage of light minerals in sand particle in the studied series soils ranged between (88.6% - 94.5%), which is an indication of the weak weathering processes in these sediment materials. And the dominance of the quartz, followed by calcite, feldspar group, gypsum, the group of mica and finally the chert mineral respectively. The highest percentage of quartz mineral was (42.5%) at the surface horizon of the MF11 series and the lowest value (33.2%) at the subsurface horizon of the MW3 series at average of (38.3%), and this could be due to its resistance to weathering due to the nature of its chemical bonds and its hardness, it is 7 on the Mohs scale of hardness, does not contain cracks, and because of its light weight, it is carried by the water to great distances as it is deposited when the momentum of the transmission forces decreases. Therefore, it is the most stable mineral under sedimentary conditions and is usually from second and third sedimentation cycles [24] . It is followed by calcite mineral ranging between (16.4%) in the surface horizon of the MW3 series and the lowest value is (7.1%) in the last horizon of the MW5 series at average of (10.35%), feldspar minerals (orthoclase and plagioclase) as the highest value it has (12.2%) at the surface horizon of the MW3 series, and its lowest value is (6.3%) at the last horizon of the MF11 series at a rate of (8.84%). The abundance of feldspares is an excellent indicator of the existence of a dry climate in its environment and it is used in that to explain the existence of ancient climates [25] . Its related with quartz is considered an important key to knowing the history of sediments. As the size of feldspar decreases relative to quartz, it indicates the effect of physical forces on its weathering [26]. The effect of these forces is more than chemical weathering processes in dry climate regions, then gypsum mineral with its highest value (8.2%) at the surface horizon of DM97 series and its lowest value (5.8%) on the subsurface horizon of the MW5 series at average of (6.62%), followed by minerals Mica (muscovite and biotite), whose percentage is noticeably lower compared to the previous minerals, and ranged between the highest value (9.7%) on the first horizon of the MW3 series and the lowest value (3.7%) on the subsurface horizon of the MF11 series at average of (6.21%). This can be attributed to weak weathering resistance and weathered to smectite minerals under dry and semi-arid conditions. It is a flaky mineral with a hardness (2 - 3 mohs) and a parallel opacity, and because of its lamellar shape, it can be washed from coarse sand and tends to aggregate and precipitate in the size of fine silt and finally the chert mineral as it has the highest value for it (5.2%) at the surface horizon of the MW5 series and the lowest value is (3.6%) at the subsurface horizon of the MW3 series, the subsurface horizon of the DM97 series and the last horizon of the MF11 series, at average of (4.11%). It is followed in order by the minutes of rock fragment, as it was the highest value (38.5%) on the last horizon of the MF11 series and the lowest value (11.9%) in the surface horizon of the MW3 series with a rate of (25.60), which is one of the common fines in coarse sand and can be found in fine sand. Despite their many types, Carbonate Rock Fragment is common in calcareous soils, which indicates its dry climate [27] . It may be accompanied by crystals of feldspar and some ferromagnetic minerals. The rocky particles are soft and more sensitive to weathering. Therefore, one of the characteristics of sand deposited in aqueous sedimentary conditions is that it is rich in quartz and rock fragment that do not last long in sediments [25] , and that their percentage increase in MF11 series horizons indicates that Its proximity to the source of sedimentation and it did not cover long distances. As the survival of the rock fragment during the process

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of transport by the river is not easy because the size of most of them is reduced to be the size of clay or silt. and its percentage may increase due to additions from the branches of the channels, which compensates for the deficiency resulting from the erosion process [28] , and it may be due to mechanical erosion that overcame chemical weathering under conditions of rapid erosion that can quickly transfer materials or particles by water. Therefore, the unstable minerals do not have sufficient time to be exposed to the processes of weathering and corrosion, so their proportions remain high in sediments [30] . The difference in the proportions of minerals in these series is due to the possibility of variation in the weathering resulting from the influence of the management methods used in the exploitation of these soils from plowing. Irrigation and fertilization, in addition to the minerals carried by sediments during their deposition.

The weathering that occurs in sedimentary soils includes the weathering of minerals at their original source as well as mechanical weathering during transport, then weathering that can take place on them while they are stable. It is therefore, and in general, does not give a real value to each of these stages, which may differ in their values. As for the weathering index, it indicates the weakness of the weathering process due to the high percentage of rock fragment and a decrease in the percentage of chert mineral while quartz and feldspar minerals appeared within the specified levels of sedimentary soils, the highest value of weathering index reached 1.755 in the surface horizon of the MW3 series, while the lowest value of 0.855 appeared at the last horizon. For MF11 series, at average of 1.22 for all studied sites. This can be attributed to the fact that these horizons may have been geomorphological surfaces with moist environmental conditions that contributed to the weathering of their minerals, and then they were covered with fresh sediments. Its decline in some horizons may be due to the fact that it is a sediment that has not been exposed to weathering for a long period of time or that it has not had sufficient time to weather its minerals [29].

Table 3. Light minerals of sand fraction of soil series study

Physio. unit	Series	Depth cm	%	Quartz	Feldspar g.	Calcite	Gypsum	Chert	Mica G.	Rock fragment	Wrl*
River Levee	MW3	27-0	91.2	38.4	12.2	16.4	7.5	3.9	9.7	11.9	1.755
		63-28	89.6	33.2	9.8	13.2	7.1	3.6	9.1	24	1.089
		110-64	90.5	34.1	7.4	15.1	6.2	4.1	8.2	24.9	1.183
Irrigation Levee	MW5	27-0	92.5	39.8	9.4	8.2	6.3	5.2	5.9	25.2	1.301
		62-28	93.4	37.8	8.5	7.3	5.8	4.1	5.2	31.3	1.053
		63-104	91.7	39.2	6.3	7.1	6.1	4.3	5.7	31.3	1.157
River Basin	DM97	28-0	90.2	37.6	11.7	11.3	8.2	4.1	4.8	22.3	1.226
		65-29	89.3	41.7	9.2	9.7	6.7	3.6	7.6	21.5	1.476
		110-66	88.6	38.1	8.2	9.1	6.2	3.7	4.1	30.6	1.077
Dipression	MF11	29-0	93.2	42.5	7.6	8.2	6.2	4.5	4.3	26.7	1.370
		76-30	94.5	38.6	6.9	8.3	6.5	4.1	3.7	31.9	1.101

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		112-77	91.4	34.7	6.3	6.7	6.1	3.6	4.1	38.5	0.855

Wrl=(Quartz + Chert) / (Feldspar + Rock Fragment)

3.4.Heavy minerals of sand fraction

Heavy metals are associated with the geological components of soils and clearly reflect the characteristics of the original source of the rocks. And which are usually derived from igneous and metamorphic rocks exposed in northeastern Iraq and the adjacent areas, the proportions of heavy metals in the fine sand mineral indicated in table (4) range between (5.5-10.4%) and average of 8.13% for the general horizons studied. The opaque minerals were dominant and gave the highest values, which amounted to 41.2% at the surface horizon of the MW5 series, at average of 39.04% for the general horizons, followed by the pyroxene group of minerals with the highest value being 9.4% in the surface horizon of the MW5 series also at average of 8.42%, then the group of amphibole minerals, which was the highest It has a value of 8.1% at the surface horizon of the MW5 series, at average of 7.25%, then comes the minerals of muscovite, chlorite, zircon, biotite, tourmaline, garnet, epidot, sterite, kyanite, and finally, the rutile mineral. while pyroxene mineral ratios decreased with depth in MW3, MW5, and DM97 soil series, while they increased with depth at MF11 series. As for the weathering index values, they ranged between 0.417-0.762, which are low values due to the high percentages of amphibole and pyroxene minerals compared to zircon and tourmaline minerals.

Table 4. Heavy minerals of sand fraction of soil series study

Physiog. unit	**Series**	**Depth cm**	**%**	**Opaque mineral**	**Biotite**	**Muscovite**	**Pyroxene**	**Amphibole**	**Chlorite**	**Zircon**	**Garnet**
River Levee	MW3	27-0	8.8	39.6	3.1	4.8	9.2	7.2	5.3	4.3	2.8
		63-28	10.4	36.8	3.6	4.7	8.8	6.9	5.7	3.8	3.2
		110-64	9.5	38.1	3.5	5.2	8.9	6.7	5.6	4.6	3.5
Irrigation Levee	MW5	27-0	7.5	41.2	6.3	6.7	9.4	8.1	6.2	4.2	3.5
		62-28	6.6	38.4	5.7	7.3	8.4	7.5	6.7	3.9	3.8
		63-104	8.3	39.7	6.2	6.8	8.7	7.3	7.3	4.8	3.2
River Basin	DM97	28-0	8.5	39.6	6.1	7.4	8.1	7.3	5.8	5.8	3.7
		65-29	7.9	41.1	5.9	7.8	7.9	7.5	5.9	6.3	2.9
		110-66	9.2	38.1	5.4	8.2	7.5	6.8	6.4	6.8	3.6
Dipression	MF11	29-0	6.8	39.4	4.5	6.9	7.8	7.6	6.7	7.3	3.5
		76-30	5.5	38.6	4.9	6.4	8.2	6.9	7.1	7.4	3.8
		112-77	8.6	37.9	6.2	7.6	8.1	7.2	7.3	6.7	4.1
Physiog. unit	**Series**	**Depth cm**	%	Epidote	Rutile	Tuarmaline	Kyanite	Stuarolite	Weathered	Wrh*	
River Levee	MW3	27-0	8.8	3.2	1.5	4.5	1.7	2.2	10.6	0.537	
		63-28	10.4	3.1	1.7	3.8	2.1	2.6	13.2	0.484	
		110-64	9.5	3.5	2.1	4.1	1.9	3.4	8.9	0.558	

Irrigation Levee	MW5	27-0	7.5	3.1	1.9	3.1	2.4	3.5	0.4	0.417
		62-28	6.6	3.5	1.8	4.2	2.1	2.9	3.8	0.509
		63-104	8.3	3.2	2.4	4.7	2.2	3.1	0.4	0.594
River Basin	DM97	28-0	8.5	3.3	1.7	3.8	2.3	2.6	2.5	0.623
		65-29	7.9	2.8	2.4	3.7	1.9	3.2	0.7	0.649
		110-66	9.2	3.4	2.3	3.8	2.8	2.7	2.2	0.741
Dipression	MF11	29-0	6.8	2.9	2.1	4.3	2.4	2.8	1.8	0.753
		76-30	5.5	3.1	1.9	4.1	2.1	3.1	2.4	0.762
		112-77	8.6	3.3	1.7	3.9	1.9	3.2	0.9	0.693

*Wrh = (zircon + Taurmaline) / (amphibole + pyroxene)

4. CONCLUSIONS

The results indicated that all soil series represent sedimentary soils with materials of river origin transported and have different texture type dependent on the physiographic location , sand particle dominate at the series of river levee while clay particles dominate at depression unit. Mineral analysis of fine sand particles showed the dominant of quartz minerals, then calcite and feldspar for light sand minerals, while heavey sand mineral appear dominate of opaque minerals, pyroxene and amphibole, the results of weathering index showed low values to indicate a low rate of weathering in the soil.

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