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Mineral Composition of Fine Sand Sediments in Euphrates River Deposits in Some Iraqi Soils North and South of Hindiya Dam

I. H. AL- MAMOORI and S. K. ESSA
Department of Soil Sciences and Water Resources - College of Agricultural Engineering Sciences - University of Baghdad, Iraq
[1] istabraq.halal1107a@coagri.uobaghdad.edu.iq
[2] salman.essa.52@gmail.coasm

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Abstract

*The study was conducted to determine the nature of the mineral composition of the fine sand fraction in the Euphrates River sediments in some Iraqi soils north and south of Al-Hindiyah Dam. Mineral examinations of the fine sand fraction using a polarized light microscope in the study soils showed the dominance of light minerals (quartz in its two types, monocrystalline and polycrystalline, feldspars in its types, orthoclase, plagioclase and microcline, evaporite salts), while heavy minerals were represented by minerals (mica in its two types, muscovite and biotite, chlorite, pyroxene minerals, amphiboles, and tourmaline). The results of the study showed the effect of Al-Hindiyah Dam and the regulators built on it on the mineral distribution of the Euphrates River sediments in the soils of the study area.***

Keywords: heavy minerals, light minerals, sediments, polarized light microscopy

Introduction AL- Hindiya Dam is the oldest hydraulic structure located on the Euphrates River. It was built between (1909-1913), and its length is 240 m. It consists of (3) basins, and each basin has (12) slots, each of which is (5) m wide. It has a movable bridge and (36) slots. It was built at the intersection of the Hilla River, which heads east, and AL- Hindiya River, which is the main Euphrates River. The dam regulates the water coming to AL- Hilla River, the Musayyib Canal, the Kafil Canal, the Husseiniya Canal, Bani Hassan, and other irrigation canals, as well as regulating the flow of water going to the south. The dam went through several stages during its construction, which can be followed from the attempt to divert part of the Euphrates water to the Hilla River in 1844 until the old dam was replaced with a new one in 1988, which is the current dam, and went through several developments between the two dates.

The study of the mineral composition of soils is of great importance in determining the factors of soil formation and geological and pedogenic changes. In addition, it is an indication of the soil formation and the extent of its development and is of great importance for understanding the inheritance of soils in addition to estimating the degree of homogeneity in the soil, through studying and analyzing its mineral components (King, 2017).

There are many factors that affect the mineral composition of river sediments and determine their quantity and quality, such as the nature of the original material and the source rocks from which they came, and the physical sorting determined by transport factors and hydrodynamic conditions, which play an important role in the sedimentation process and the mechanical abrasion that occurs during the transport process, and its primary role in changing the shape and size of the grains in terms of breakage, roundness and curvature, in addition to the chemical weathering factors that lead to the loss or change in the composition of minerals, especially unstable ones. The differences and changes that occur in the transported sediments in terms of their shape on the one hand and the structures present in them on the other hand, such as cracking, reflect the extent of the influence of the sedimentary factor to which the sediments were exposed and the time and distance they spent during the transport process. He added that what controls the presence of grains and their arrival to long distances is their large size, specific weight and resistance to mechanical abrasion, in addition to some characteristics such as the shape of the grain, impurities and cracks present in it from the source rocks, and these characteristics are considered inherited from the original material. Frakes Hou (2004).

The sediments carried by riversare an important standard and good analytical guide for studying sedimentation patterns, because they contain a heterogeneous mixture of primary and secondary minerals in addition to weathering products. These sediments pass through diverse areas and are exposed to different conditions, as they consist of particles resulting from the disintegration and decomposition of rocks that make up the Earth's crust due to weathering processes, and can be transported by water currents until they are finally deposited. Usually, water, wind or glaciers are the media through which these sediments are transported. River sediments include particles of various sizes, including clay, silt, sand and gravel, where clay dominates these components. Thus, the contribution or difference of more than one source of sedimentation (such as rivers) in a certain area leads to a variation in some soil properties, especially physical, chemical and mineral, as the clays that make up sediments and soil come from multiple sources and are either the result of erosion of soil and rocks that have been exposed to weathering processes, which affect more than 60% of the Earth's surface, or from the crystallization process resulting from the interaction of salt solutions and silicates. In the first case, the size and mineral properties depend on the processes of transport and sedimentation, and its characteristics are inherited from the original rocks. In the second case, it represents a new formation (Meunier, 2005).

River load includes all the materials that flow from the source and that the river carries with it through the water currents that carry those materials as they flow towards the estuary. River loads represent the sediments that rivers carry when they flow. The importance of studying them lies in the fact that they are a reflection of the products of the erosion and weathering process that occurs to rocks as well as soils, as they are used in studying the rates of erosion and sedimentation (Al-Mansouri and Al-Mahmoud, 2006).

In a study conducted by Saleh and Muhaimid (2010) to determine the nature of the mineral composition of several soils representing some of the river shoulder soil series in several areas in the middle of the sedimentary plain, including the Latifiya Project and the Great Musayyib Project, the results of the study showed a decrease in the proportions of heavy minerals compared to the proportions of light minerals in the fine sand fraction, as a result of their exposure to weathering processes in their source locations or during transport and sedimentation processes. They attributed this to the nature of the mineral composition of the source of these deposits, and the nature and type of the original rocks that formed the heavy minerals, which were basic, ultrabasic and intermediate igneous rocks, and metamorphic rocks followed by acidic igneous rocks. As noted, the opaque minerals, from which the heavy minerals are mainly composed, were distributed in homogeneously in the horizons of the study pedons, and the dominance of amphibole minerals was within the heavy part of the sand section, while quartz minerals dominated within the light part of it. The results of the study showed the dominance of mica and smectite minerals in the minutes of the coarse clay fraction.

Al-Khafaji and Al-Najjar (2010) found orthoclase in their study area (Tall Al-Lahm in Thi Qar Governorate) based on its optical properties, as it was characterized by its almost completely faceted prismatic shape, its cloudy color, in addition to simple twinning, and it is one of the optically heterogeneous minerals and has a dual optical axis. They also diagnosed the plagioclase group of minerals based on the phenomenon of repeated twinning, which is considered a characteristic of this group. Albite is characterized by an angle of darkness that ranges between 12-20 degrees, and the Albite mineral constituted 0.9-0.7% in the study model in southern Iraq. They also showed that the Albite mineral has close proportions in different sand sizes**Materials and methods**

Study sites

The study area was represented by eight soil pedone sites for part of the agricultural lands located along the Euphrates River within the provinces of Babylon and Najaf, starting from the north of Al-Hindiyah Dam at the district of (Jurf Al-Nasr) and reaching the district of (Al-Mashkhab) in the south, where the study area was divided into two sections, the first section includes six sites to the north of Al-Hindiyah Dam, the first is located in the district of (Jurf Al-Nasr) to the right side of the Euphrates River at coordinates E 44°.186740, 32°.940900 N, while the second is behind the regulator of the Great Musayyib Project (left side of the Euphrates River) E44°.292700, 32°.790860 N, and the third is at the area of Hor Hussein (to the right side of the Euphrates River) E 44°.266826, 32°.769929 N, and the fourth is at the back of the regulator of the old Husseiniya (left side The right side of the Euphrates River) E 44°.264011, 32°.741138 N, the fifth at the Umm Aruk area (on the right side of the Euphrates River) E44°.262273, 32°.734435 N, the back of the Shatt al-Hillah regulator (the left side of the Euphrates River) E 44°.270211, 32°.728885 N, while the second section includes three sites to the south of the Hindiya Dam, the first in the village of al-Tubar E 44°.263787, 32°.490842 N, and the second in the district of al-Mashkhab E 44°.491207, 31°.840711 N (and they are located on the left side of the Euphrates River).

- Field procedures

The eight pedons were excavated and then morphologically described. Soil samples were collected for each horizon from each pedon in a homogeneous manner, then dried, ground and passed through a sieve with a 2 mm hole diameter, placed in nylon bags, marked and stored. The surface and last horizons from each pedon and selected samples of the study soils were selected for the purpose of conducting the separation process and then studying the mineral properties of the fine sand separation using a polarized light microscope.

-Initial treatments and removal of binding materials, which include four stages:-

1- Removal of dissolved salts: - They were removed with distilled water as mentioned by Kunze, (1962).
2- Removal of carbonate minerals: - Carbonate minerals were removed by acidified sodium acetate NaOAC with acetic acid pH=4.5 according to the method recommended by Rabenhors and Wilding, (1984).
3- Removal of organic matter: - This was done by using sodium hypochlorite solution NaOCL pH=9.5 and a concentration of 14% according to the method of Anderson, (1963).
4- Removal of free oxides: - They were removed by citrate - bicarbonate - sodium dithionite (C.B.D) according to the method of Mehra) and Jackson, (1969).

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-Separation and fractionation

The process of separating sand particles by wet sieving method using a sieve with holes diameter of 50 micrometers, and the clay particles were separated by sedimentation method based on Stocks Law, taking into account the temperature as stated by Jackson (1979.(

-Examination of sand minerals using a polarized light microscope

This stage included separating heavy sand minerals from light ones according to (1962) the method of Milner, using bromoform liquid at a specific gravity of 2.89. After drying the heavy and light sand minerals in air, they were spread on a special glass slide with dimensions of 25*75 mm and the minerals were fixed with an adhesive with a refractive index of 1.54, using Canada balsam. Then the slides were examined with a polarized light microscope following the method described by Brewer (1976) according to the method followed by Nesse (1977) and (2000). All sand minerals were identified separately, heavy and light, and they were distinguished according to the optical and visual properties of each mineral. The samples were photographed with a German-made Lietz microscope (Figure 2) in the Department of Earth Sciences / College of Science, University of Baghdad. The mineral ratios were calculated using a point counting device for 250-300 grains of sand per slide according to the method followed by Black (1965).

Procedure:-

-25 grams of soil sample were taken.

-The sample was disintegrated and the grains did not stick together by mixing, moving and hitting the sample with a light wooden cylinder.

-The sample was mixed with distilled water to ensure the process of disintegrating the grains well and then dried in the drying oven.

-The sample was washed on a 63 micron sieve to get rid of the clay and silt and isolate the sandy part.

-The sandy part was taken and washed well with water to get rid of the clay stuck to the grains.

-The sand grains were washed with acetone to ensure that the grains were washed.

-A weight of (15 grams) was taken to carry out the sieving process using sieves to isolate the fine sand and very fine sand that will be used to separate heavy metals from light ones. The use of these two parts of sand is because this size range is suitable for diagnosis under the polarizing microscope, which gives the optical properties necessary for diagnosing minerals.

-A weight of (5 grams) was taken from the fine and very fine sandy part for the purpose of separation by heavy liquid bromoform.

-The heavy metals part was separated from the light metals by heavy liquid bromoform, according to the method suggested by (Tucker, 1988) using a separating funnel.

-The heavy and light metals part was weighed after the separation process was completed by a sensitive balance to calculate the weight percentage of heavy metals to light metals.

-Glass slides were made, then the metals were sprinkled on them and fixed by Canada balsam.

-The metals were diagnosed based on the optical properties of the metals studied through the polarizing microscope, and their percentages were determined by the point counting method, according to the method suggested by (Fleet, 1926

Results and Discussion

Light minerals: They include:

1- Quartz Minerals Group

The results of the polarized light microscope examinations in Figure 1 showed that there are two types of quartz minerals in the study soils, namely monocrystalline quartz and polycrystalline quartz. Monocrystalline quartz was identified in Figure (1a) within the surface horizon of the soil of Pedon Shatt al-Hillah, north of the Hindiya Dam, according to its wavy and straight extinction, as the linear extinction indicates that the origin of the mineral is igneous, and its particles were characterized by being medium-sized and semi-circular (Subrounded), and this is a result of the repeated process of sedimentation and carrying, and then sedimentation again during its transport in the river load, which caused the polishing of the mineral particles. As the results of Table 1 showed, the percentages of the metal ranged between 30.6-38.4%, where the highest percentage was within the subsurface horizon of the soil of the Pedon Al-Musayyab to the north of Al-Hindiyah Dam, and the lowest was within the surface horizon of the Pedon Shatt Al-Hillah soil to the north of Al-Hindiyah Dam. It was noted from the results obtained in Table 1 that the highest percentage of metal particles was within the soils of the first section in the study soils (north of Al-Hindiyah Dam). The reason for this is the variation in their sizes, in addition to the role of Al-Hindiyah Dam and the regulators in retaining and sedimenting the fine-sized particles of the sand section when the speed of the carrying water currents decreases, which indicates the presence of the single quartz mineral within the fine and medium-sized sand particles deposited in the north of the dam. In general, the presence of the metal increased within the soils of the first section (north of the dam) compared to the soils of the second section (south of Al-Hindiyah Dam) for both depths and in all sites.

The results of the polarized light microscope examination in image 1b showed the optical and morphological characteristics of the polycrystalline quartz mineral, most of whose particles were characterized by being granular in shape and having a wavy extinction, and an angular to sub-circular shape (anguler-sub-around), and consisting of two or more crystalline units that differ in optical orientation, and its presence indicates that its origin is from metamorphic rocks that were exposed to transformation factors such as pressure and heat (Al-Taie, 2016; Jassim and Al-Hazza, 2020). The results of Table 1 showed that the percentages of polycrystalline quartz were less than the percentages of monocrystalline quartz in all the study soil pedons at both depths. This is due to the increased rate of transformation of polycrystalline quartz into monocrystalline quartz due to transport and sedimentation processes, the continuation of which leads to its destruction and transformation into a more stable quartz mineral, more tolerant of transport and sedimentation processes. These results are consistent with many studies conducted on river sediments in Iraq (Abdul Rahman and Al-Shammari, 2009; Al-Shahmani, 2020). The results of Table 1 showed that the percentages of polycrystalline quartz ranged between 1.4-3.3%, as the highest value was recorded in the surface horizon of the soil of Pedon Jurf Al-Nasr and the subsurface horizon of Pedon Village Umm Arouk within the soils of the first section (north of Al-Hindiyah Dam), while the lowest value appeared in the surface horizon of Pedon Al-Mishkhab within the soils of the second section (south of Al-Hindiyah Dam). The results show that the percentages of polycrystalline quartz were high within the surface horizons of the soils of the first section (north of Al-Hindiyah Dam), compared to their percentages within the soils of the second section (south of Al-Hindiyah Dam). This is due to the difference in soil texture between the soils located north and south of Al-Hindiyah Dam. These results are consistent with what Al-Shahmani (2020) and Al-Jaf (2013) reached, as the percentages of polycrystalline quartz increased with a decrease in the size of the particles within the soils they studied. Al-Khafaji and Al-

Najjar (2010) shared their opinion, as they showed that there was an increase in the percentages of Polycrystalline quartz within small particles deposited within fine particles.

2- Feldspars

Feldspars are classified into two types: alkani feldspars and plagioclase feldspars. The results of Table 1 showed that the percentages of basic feldspar minerals (Orthoclase) ranged between 2-4.7%, where the highest value was in the surface horizon of the soil bed of the village of Tubar within the soils of the second section (south of Al-Hindiyah Dam), while the lowest value was in the subsurface horizon of Shatt Al-Hillah soil within the soils of the first section (north of Al-Hindiyah Dam), which confirms the dominance of these minerals within the large-sized particles represented by sand particles that were deposited in the soils of the second section (south of Al-Hindiyah Dam), due to the difference in the speed of the flow of water currents carrying sediments, which led to the deposition of these minerals with them. This is consistent with what Rahl and Al-Aqidi (2009) found in their study on some river basin soils from the sedimentary plain, as they found agreement in the distribution pattern of feldspar minerals with the texture of those soils. The basic feldspar mineral (Orthoclase) appeared under the polarized light microscope, image (1c) in two colors, white The pink, with some black spots on its surface, which are attributed to a state of transformation that occurs to the mineral towards other minerals, and the mineral appeared in the form of an undissolved minute with medium roundness and curvature, and another part of it appeared in the form of pure minutes with medium roundness, and a part in the form of decomposed minutes with good roundness and low curvature, and this variation in the morphological properties of the mineral minutes is due to the effect of the distance traveled by those minutes and their impact on mechanical weathering, in addition to erosion and repeated sedimentation, and their transport by river load, which led to the difference in their roundness, and these results are consistent with what Al-Fatlawi (2016) obtained, as she showed that the orthoclase mineral is one of the minerals that crystallize within the monoclinic system, and has a prismatic crystal, and often forms simple twinning and some parts of it may change to sercite and kaolinite and its colors range between pink and white or red or gray, and sometimes colorless, and rarely yellow or green in color, with a glassy luster, semi-transparent, and its hardness is 6. Its specific gravity is 2.57.

Among the feldspar minerals that were diagnosed in the soils of the current study is the microcline mineral, whose percentages ranged between 2.1 - 4.3% (Table 1). The highest value was recorded in the surface horizon of Pedon Al-Mishkhab in the soils of the second section (south of Al-Hindiyah Dam), and the lowest in the subsurface horizon of Pedon Umm Arouk in the soils of the first section (north of Al-Hindiyah Dam). The results showed high percentages of the mineral in the soils of the second section (south of Al-Hindiyah Dam). The reason for this is the increase in the size of its particles and its deposition with large sand particles that are increasingly deposition south of the dam, in addition to its light specific weight, which led to its easy transport by the water currents, its transportation, sorting and re-deposition in the soils located south of the dam. As the polarized light microscope examinations in image (1d) showed, the distinctive morphological characteristics of the microcline mineral in the soils of the current study showed that the mineral was glassy and foggy, with black spots spread on its surface. The mineral is characterized by the presence of two forms, Rounded Sub and Angular Sub, and it has clear cracking in two perpendicular directions, giving it a perpendicular structure, Quadrilled, which distinguishes it from the orthocline mineral (Essa and Al- Sheikhly 2001). In addition, there is a type of alteration that can be distinguished by the appearance of parallel lines on the surface of the mineral, as Bullock et al. (1985) showed that this type of transformation in the microcline mineral begins in the form of parallel lines present on the surface of the mineral, which lead with the progress of weathering, especially chemical weathering, to its transformation into another mineral. The results of the polarized light microscope examination in image (1e) showed the optical and morphological properties of the Plagioclase mineral particles, as its particles were characterized by being multi-shaped and multi-colored, and the mineral appeared white, and had an angular to semi-angular shape, with angular or rounded edges, as the Plagioclase mineral is characterized by the property of multiple twinning, which distinguishes it from the basic feldspar mineral, its specific gravity is about 2.7, its appearance is scratched, and it has a glassy luster, with uneven surfaces, the mineral is exposed to the state of irregular linear transformation, and the mineral is characterized by the property of luster and is often called moonstone. Plagioclase grains are exposed to different degrees of decomposition depending on the degree of weathering and the distance it travels during the transport process (Akinlua *et al*., 2015).

The results of Table 1 showed that the percentages of plagioclase mineral particles ranged between 1.9-4.9%, as the highest percentage was recorded in the surface horizon of the old Pedon Al-Hussainiya soil within the soils of the first section (north of Al-Hindiya Dam), and the lowest in the surface horizon of Pedon Umm Arouk soil north of Al-Hindiya Dam. In addition, the results showed that the horizontal distribution of plagioclase mineral particles did not take a specific pattern within the soils located north and south of Al-Hindiya Dam, and took a different pattern in distribution. This variation in distribution is due to the difference in the conditions of the transport and deposition processes, in addition to the mechanical effects and different weathering processes that the mineral is exposed to during the transport process, as it is one of the minerals that are easy to weather and transform (Al-Ubaidi and Issa, 2011).

3. Evaporite salts

These are minerals resulting from the evaporation of water with a high concentration of salts according to a specific arrangement and according to the solubility of the salt. The sediments that develop from the transformation of other evaporites into this group, in addition to salt mineral rocks that are formed through different mechanisms, such as temperature changes or water mixing. The evaporite particles that were reshaped by salt water or wind or as evaporite particles (Babel and Schreiber, 2014). The optical properties through examination with a polarized light microscope showed the most prominent minerals of this group, which is identified as gypsum mineral, image 1f, as it was characterized by its white or yellow color resulting from its inclusion of impurities, and it had a glassy luster, a specific gravity of 2.32 and a hardness of 2. As the results of Table 1 showed, the percentages of evaporite salts in all the study soils ranged between 3.3 - 5.4%, where the highest percentage appeared in the subsurface horizon of Al-Hussainiya Pedon soil within the soils of the first section (north of Al-Hindiya Dam), and the lowest percentage was in the surface horizon of the Pedon Al-Musayyab soil within the soils of the first section (north of Al-Hindiya Dam). In general, the results of the table showed that the percentages of evaporate salts increased with depth within the soils of the first section (north of Al-Hindiyah Dam), except for the Bedoni of Hur Hussein and Shatt Al-Hilla, while their percentages decreased with depth within the Bedoni soils of the second section (south of the dam). The reason for this variation in distribution is due to the effect of the engineering structures built on the Euphrates River in the study area and the process of controlling them, in addition to the hydrodynamic conditions resulting from them.

Table 1 . Percentages of Some light sand minerals on the study soils

Location of pedon		horizon	% Quartz		%feldspar			evaporite %salt
			Mono crystalline	Poly crystalline	Orthoclase	Microcline	Plagioclase	
North of dam	jurf AL-Nasir	surface	31.7	3.3	2.4	2.9	3.7	3.8
		Sub surface	34.3	2.4	4.5	2.7	2.2	4.7
	Great Musayyib Project	surface	32.4	2.3	3.5	2.4	2.6	3.3
		Sub surface	38.4	3.2	4.4	2.5	3.2	3.5
	Hor Hussein	surface	34.3	2.3	2.3	2.2	2.4	4.5
		Sub surface	35.7	2.1	3.2	2.4	3.7	3.5
	Al Husseiniyah	surface	32.4	2.5	2.4	2.7	4.9	4.6
		Sub surface	31.3	2.3	4.5	2.7	2.3	5.4
	Umm Aruk	surface	34.6	2.2	3.4	3.5	1.9	3.4
		Sub surface	32.8	3.3	4.5	2.1	3.8	4.6
	Shatt Al-Hilla	surface	30.6	2.4	3.6	2.2	2.6	4.6
		Sub surface	33.4	2.8	2.0	4.1	3.1	3.4
South of dam	village Al-Tubar	surface	36.2	1.7	3.3	2.2	4.7	4.4
		Sub surface	36.6	1.5	4.7	3.3	3.4	3.6
	Al-Mishkhab	surface	32.7	1.4	3.5	3.4	4.7	4.7
		Sub surface	30.9	2.3	2.3	4.3	4.2	4.5

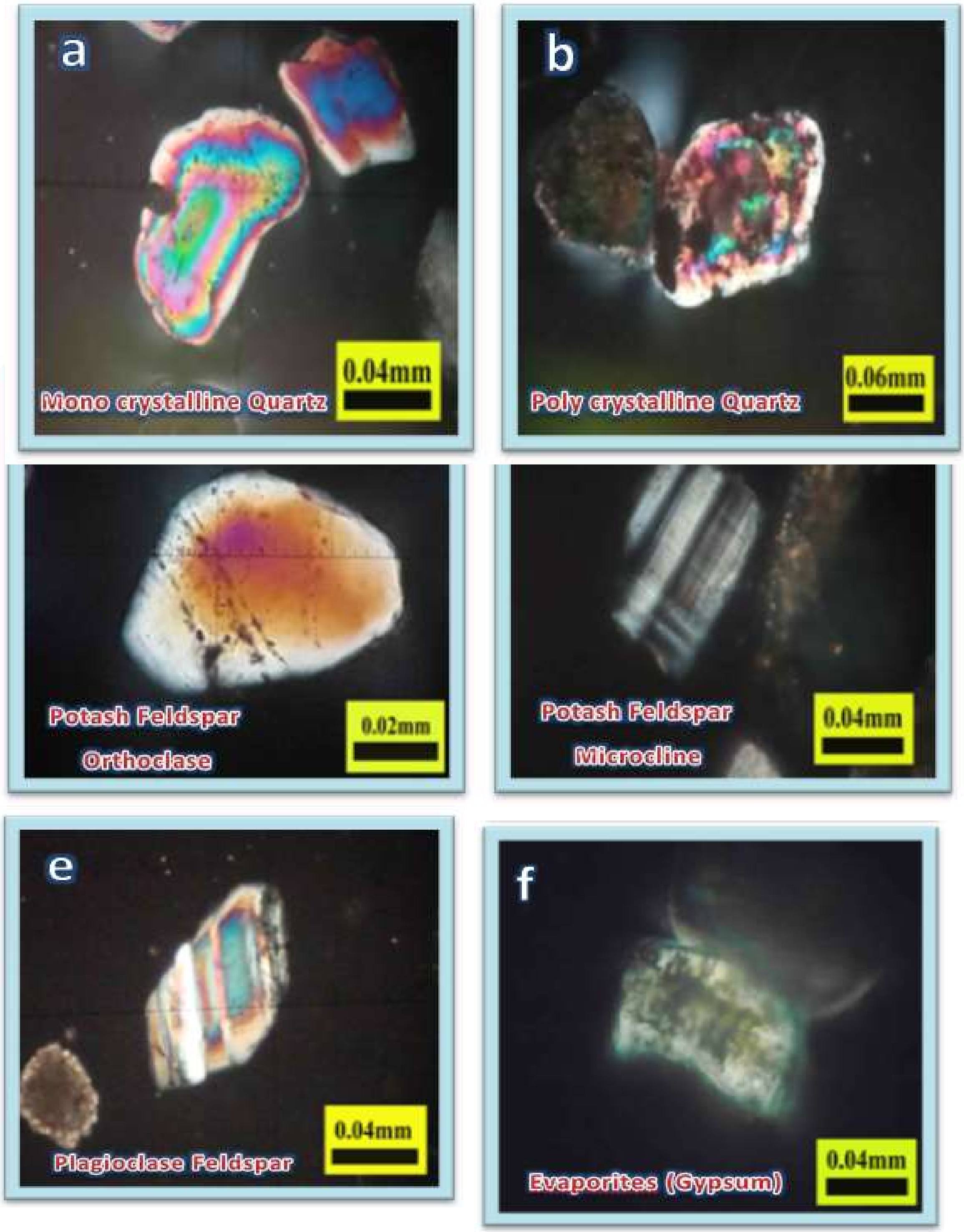

image1. Some light sand minerals of study soils

Heavy sand minerals:

1- Mica minerals

The results of the polarized light microscope examination showed the morphological characteristics of the particles of mica minerals of both types (muscovite and biotite) shown in the picture (e, f4-3) and (a4-4), as the muscovite mineral appeared in the surface horizon of the soil of Pedon Umm Arouk, in a flaky form, brown in color and the other part of it was white, with spots of iron oxides on its surfaces in brown color and in different degrees, with a pearly or glassy luster, while the biotite mineral particles appeared in the surface horizon of the soil of Pedon Hor Hussein, in the form of flaky particles, brown in color, with multiple shapes and sizes. The results of Table 4-23 showed that the percentages of muscovite in the study soils ranged between 3.2 - 8.1%, where the highest percentage was recorded in the surface horizon of the soil of Pedon Jurf Al-Nasr north of Al-Hindiyah Dam, and the lowest percentage was recorded in the surface horizon of the soil of pedon Village Al-Tubar south of Al-Hindiyah Dam. As for the biotite mineral, its percentages ranged in Table 2 between 3.3 - 6.3%, where the highest percentage was recorded in the surface horizon of the soil of Pedon Jurf Al-Nasr north of Al-Hindiyah Dam, and the lowest percentage was recorded in the surface horizon of the soil of Pedon Al-Mishkhab south of Al-Hindiyah Dam. The high deposition of mica minerals in the soils of the first section north of the dam is due to the effect of the location of the dam and the regulators built on it, and their impact on weathering processes during the process of transport and deposition from their source, which makes their sizes smaller particles, in addition to their low specific weight.

2- Chlorite Group

The results of the polarized light microscope examination of the morphological characteristics of the chlorite group of minerals, shown in Figure (3-4b), showed the presence of chlorite, which was diagnosed by its appearance in a green color of varying degrees, a plate-shaped form, and a pearly or glassy luster. As the results of Table 20-4 showed, the percentages of chlorite in the study soils ranged between 6.3 - 9.9%, and the highest percentage was in the surface horizon of the soil of Pedon, Al-Tubar village, within the soils of the second section (south of Al-Hindiyah Dam), and the lowest was in the surface horizon of the soil of Al-Hussainiya within the soils of the first section (north of Al-Hindiyah Dam), thus recording an increase in its percentage with depth for the soils of all sites except for the soil of bedon Umm Arouk, north of the dam, and the soil of Pedon, Al-Tubar village, south of the dam. The reason for the increase in the percentages of the mineral with depth may be attributed to the nature of the variation and amount of sediments during the successive sedimentary cycles (Al-Shahmani, 2020), and as the results of Table 20 showed, the percentages of chlorite were increasing within the soils of the second section (south of Al-Hindiyah Dam), as the reason for this is due to the large size of the mineral particles and the high specific weight, Issa (2022), which led to its deposition with the coarse particles south of The dam.

3-. Group Pyroxenes

The optical and morphological properties of pyroxene minerals under the polarized light microscope, shown in Figure (3-4c), showed the presence of pyroxene in two locations. It appeared in the surface horizon of the soil of Pedon Jurf al-Nasr within the soils of the first section (north of the Hindiya Dam), where the mineral appeared in a pale green color, with clear features (high relief), and in a semi-circular shape, while it appeared in the subsurface horizon of the soil of Pedon Al-Musayyab as an unstable mineral, with a prismatic shape, and a glassy luster.

The results of Table 4-21 showed that the percentages of pyroxene ranged between 5.4 - 8.1%, where the highest percentage was recorded within the surface horizon of the soil of Pedon, Al-Tubar village, south of Al-Hindiyah Dam, and the lowest percentage was recorded within the surface horizon of Pedon Jurf Al-Nasr soil, north of Al-Hindiyah Dam. As the results of Table 21 showed, the percentages of the mineral increased within the soils of the subsurface horizons compared to the surface horizons and for all the soils of the study except for the surface horizon of Pedon Al-Mashkhab soil. It was also noted that the percentages of the mineral increased within the soils of the second section (south of Al-Hindiyah Dam) compared to its percentages within the soils of the first section (north of Al-Hindiyah Dam). The reason for this is attributed to the large sizes of the mineral particles and its high specific weight, which led to its deposition with the coarse particles of the sediments south of Al-Hindiyah Dam due to the effect of both the location of the dam and the regulators built on it. Al-Bassam and Al-Mukhtar (2008) found that the percentages of pyroxene minerals gradually decreased with the decrease in the speed of the Tigris River current to the south, which indicates To the increase in its sedimentation with coarse particles, and Al-Shahmani (2020) shared their opinion during his study of the distribution of minerals within the sediments of the Gharraf River in Wasit Governorate.

4- Amphibole Group

Among the most important minerals identified under the polarized light microscope within this group is the hornblende mineral that appeared in the surface horizon of the ancient Pedon Al-Hussainiya soil within the soils of the first section (north of the Hindiya Dam) photo (d4-3), as the mineral was distinguished by its green color and serrated edges that reflect its exposure to weathering processes, perhaps in the source areas, or during transport and sedimentation processes. The results of Table 4-22 showed that the percentages of hornblende ranged between 5-7.5%, with the highest percentage recorded in the surface horizon of the soil of the Pedon village of Al-Tubar in the south of Al-Hindiyah Dam, and the lowest in the surface horizon of the Pedon Jurf Al-Nasr soil north of Al-Hindiyah Dam. The results showed that there is a variation in the percentages and distribution of hornblende with depth. In the Pedon soils of the first section north of the dam, its percentages increased with depth in all soils of the sites except for the old Pedon Al-Hussainiyah soil, while the percentages of the metal decreased with depth in the Pedon soils of the second section (south of Al-Hindiyah Dam). The reason for this variation in distribution is due to the variation in the distribution of the metal between coarse and fine sand particles. Al-Ubaidi (2008) indicated that the reason for the variation in the distribution of hornblende with depth is attributed to the variation in the weathering process, the nature of the mineral composition of the original materials, in addition to the conditions of the sedimentation process and the age of the sediments.

5- Tourmaline

The results of the polarized light microscope examination showed the morphological characteristics of tourmaline mineral particles shown in the image (e4-4), as the mineral particles appeared rounded, honey-colored, and clear (high relief). As the results of Table 4-28 showed, the percentages of tourmaline mineral in the study soils ranged between 3.1 - 5.8%, and the highest percentage was in the surface horizon of the old Pedon Nazim Al-Hussainiya soil at the surface horizon north of Al-Hindiya Dam, and the lowest percentage appeared in the surface horizon of Pedon Umm Arouk soil south of Al-Hindiya Dam. The results also showed that the horizontal and vertical distribution of tourmaline mineral particles did not take a specific pattern in all the study soils, which reflects their lack of influence by the location of Al-Hindiya Dam and the regulators built on it. Rather, it seems that this distribution of mineral particles is a result of the difference in the quantity and content of sediments in each sedimentary cycle (Al-Shahmani, 2020).

Table 2 . Percentages of Some heavy sand minerals on the study soils

Location of pedon		horizon	% Mica minerals		Chlorite %	Pyroxene % s	Amphibole Hornblend (%	Tourmaline %
			muscovite	biotite				
North of dam	jurf AL-Nasir	surface	6.8	5.2	8.1	5.4	5.0	4.5
		Sub surface	8.1	6.3	9.2	7.8	6.0	3.3
	Great Musayyib Project	surface	7.4	4.9	7.1	6.1	5.9	4.6
		Sub surface	5.7	6.1	9.6	7.7	6.1	4.6
	Hor Hussein	surface	4.5	5.3	7.4	7.1	5.8	3.8
		Sub surface	6.4	5.7	9.3	7.8	6.8	4.9
	Al Husseiniyah	surface	4.7	6.1	6.3	7.1	6.1	5.8
		Sub surface	6.6	4.7	7.4	7.7	5.2	3.2
	Umm Aruk	surface	5.3	4.7	8.0	6.4	5.1	4.6
		Sub surface	5.5	5.3	7.3	7.1	6.9	3.1
	Shatt Al-Hilla	surface	7.4	4.9	7.5	7.4	5.3	4.8
		Sub surface	5.7	6.1	9.6	7.7	7.2	5.4
South of dam	village Al-Tubar	surface	4.1	5.6	9.9	6.7	7.5	3.4
		Sub surface	3.2	5.3	7.1	8.1	5.2	4.6
	Al-Mishkhab	surface	7.5	4.6	7.9	6.8	6.6	4.9
		Sub surface	5.9	3.3	8.8	5.6	5.2	5.1

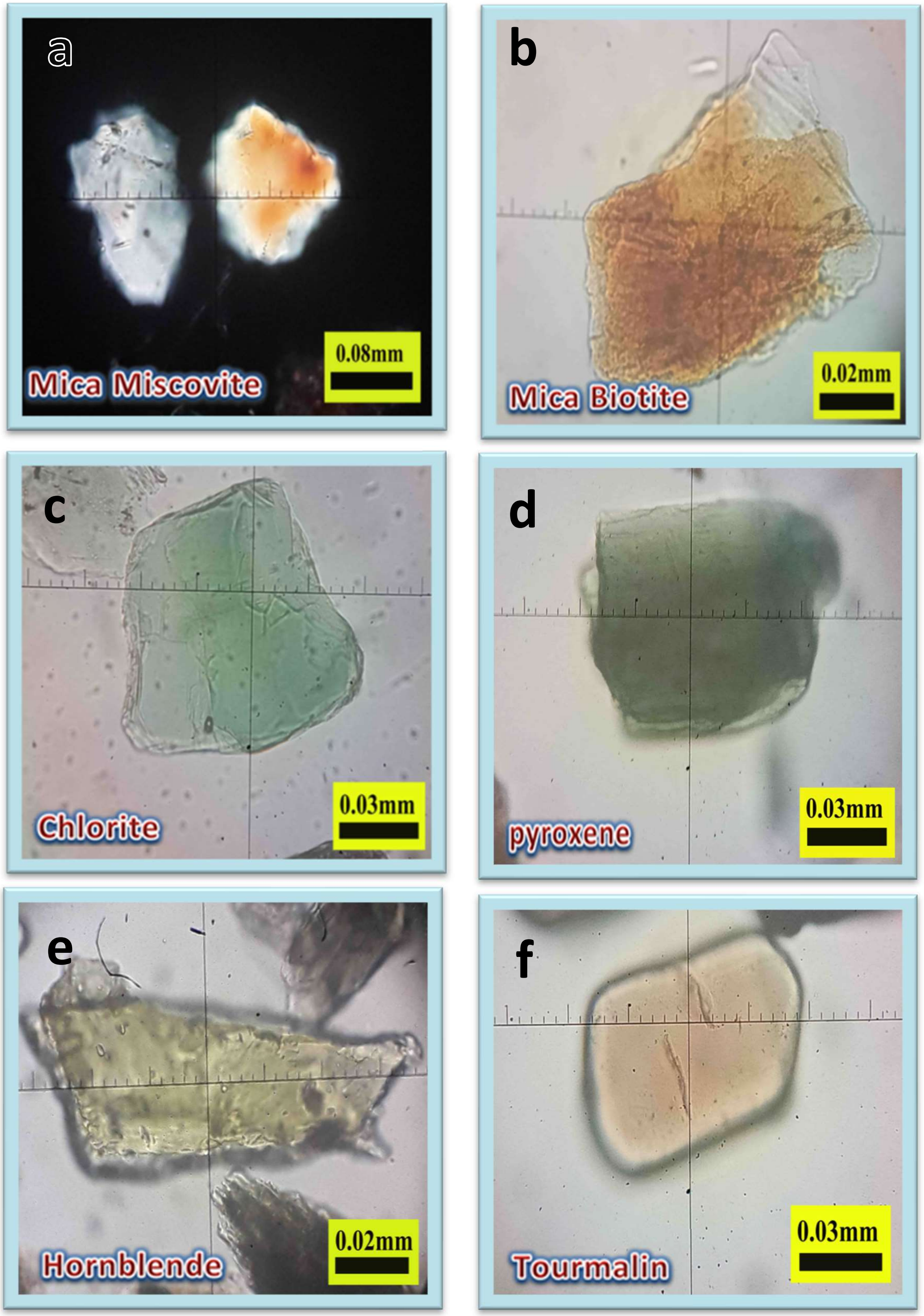

image2. Some heavy sand minerals of study soils

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