Mineralogical Analysis of Riverine Sediments in some Rivers of Basra Governorate, Iraq

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Abstract
upper and middle reaches, the rivers have high sand contents. The main aim of this research is to define the mineralogical composition of recent sediments deposited by the Tigris, Euphrates, and Shatt al-Arab rivers and to determine the provenance of these sediments. Three sites were chosen: two in the Al-Qurna region representing the deposits of the Tigris and Euphrates rivers before their confluence, and a third in the Al-Faw region representing the Shatt Al-Arab River sediments. The soil was separated into depths of 0-30 cm, 30-60 cm, and 60-90 cm at each location. The separated sand (53-5000 micrometers) was then analyzed using X-ray diffraction. The mineral compositions and their percentages were determined using a point-counting device. The results of the X-ray diffraction examinations of the Tigris River sediments showed the presence of quartz (39.9%, 38.2%, and 34.6%), calcite (31.3%, 31.2%, and 35.5%), albite (8.8%, 9.7%, and 4.8%), dolomite (4.8%, 5.6%, and 5.4%), hematite (2.0%, 1.7%, and 1.8%), and magnetite (2.9%, 3.4%, and 3.1%) across the respective depths. In the Euphrates River sediments, the mineral contents were quartz (38.4%, 38.5%, and 39.9%), calcite (36.1%, 28.4%, and 37.9%), albite (6.1%, 3.8%, and 6.0%), dolomite (4.6%, 5.4%, and 5.1%), hematite (1.3%, 1.9%, and 1.6%), magnetite (2.7%, 2.5%, and 3.1%), mica (4.2%, 7.6%, and 0.3%), and chlorite (2.5%, 2.5%). In the Shatt al-Arab sediments, the minerals identified were quartz (41.5%, 40.3%, and 57.8%), calcite (27.0%, 37.1%, and 26.9%), albite (4.7%, 3.2%, and 13.9%), dolomite (6.2%, 4.5%, and 5.1%), hematite (2.4%, 1.9%, and 1.6%), magnetite (3.6%, 3.1%, and 3.1%), mica (1.0%, 4.2%, and 0.3%), and chlorite (6.0%, 0.9%) at the respective depths. The compositions change across each section of the upper and middle reaches due to local sediment supply from arid desert areas and seasonal tributaries

Keywords: Sand, Mineral composition, minerals quartz, Tigris, Euphrates

- **Part of M.Sc. thesis of first author**

Introduction

The study of mineral composition is of great importance in knowing the factors of soil formation and pedogenic and geological changes, as well as using it as an indicator of soil formation and development through the study and analysis of mineral components [1]. The mineral composition of the soil is affected by several factors, the most important of which are climate and the parent material. The mineral composition reflects the nature of the soil and indicates its current evolutionary path. Soil minerals are indicators of the nature and intensity of the weathering processes that occur. The presence or absence of a particular mineral in the soil gives an idea of how The formation and development of this soil and the extent of the participation of its formation factors [2]. [3] demonstrated the importance of studying the heavy sand minerals present in modern sediments and their distribution, as they play a major role in distinguishing the quality of the source rocks from which these

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sediments are composed and determining the overall weathering conditions and the most important processes to which these sediments were exposed.

Light and heavy minerals are commonly used to investigate material sources and are particularly suitable for "source-sink" studies within areas with distinct sediment sources. These include riverine input and the transport of terrigenous material into the sea [4], atmospheric deposition of volcanic material into marine environments [4], and sediment transport via sea ice/icebergs. Detrital mineral indicators have proven effective in researching sediment sources. In the Siberian Arctic Shelf region, terrigenous sediments are typically characterized by finer grains and low sand content The area is influenced by multiple rivers, introducing various sediment sources such as shale, basalt, and sandstone [5]. Heavy minerals in these sediments facilitate better traceability in identifying material sources. The composition of heavy, light, and clay minerals in sediments serves as indicators of the primary material sources in the Arctic Ocean [6,7[

Sediments come from many sources, including the river's drainage basin, the continental shelf, the atmosphere, erosion of the river's bottom, mouth, and edges, and biological activities present within the ecosystem of any region. The mechanism of sediment transport occurs in two main patterns: either as a suspended load or as a bed load. The mode of transfer varies depending on how the energy reaches the particles and how these particles settle on the surface of the bottom. The bottom load occurs intermittently and in a thin layer the thickness of a few grains located at or near the bottom. Energy is generated through collisions between the rolling grains or in the form of jumps. Individually, as the suspended load, it is carried through the flow field and is completely independent of the channel bottom. Its energy is generated as a result of the turbulent movement of the water stream. This load moves at approximately the same speed as the water stream moves, while the movement of the bottom load will be at a slower rate than the average flow speed. The deposition sites for the mineral components will be The soils of the floodplains, which are called the soils of the river physiographic units, include the soils of the river shoulder units that are located on both sides of the river [9] found that non-clay minerals constituted 83% of the mineral composition, which included calcite, quartz, albite, dolomite, and gypsum. Meanwhile, clay minerals, such as chlorite, illite, montmorillonite, palygorskite, vermiculite, and kaolinite, accounted for 17%. The study also observed that the distribution of both clay and non-clay minerals varied along the courses of two rivers in Iraq .

This study aims to characterize the nature and content of suspended sediments in the Tigris and Euphrates rivers within Iraq's sedimentary Mesopotamian plain. It focuses on the quality and quantity of mineral content in these suspended sediments. By analyzing the qualitative and quantitative aspects of the suspended river load, the study can determine how close or far the sediment sources are from the river. These suspended sediments are carried to agricultural lands through river water and are deposited on the soil surface during irrigation. In this study, we use heavy–mineral analyses coupled with grain–surface textural analysis to carry out a detailed investigation of riverbed sediments in the upper–middle reaches of the Tigris, Euphrates, and Shatt al-Arab rivers; this research serves the purpose of improving understanding of the distribution features of coarse sediments in the upper–middle alluvial reaches .

Material and Methods

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Preliminary procedures

The study area was chosen within the lands located in Basra Governorate. This area represents part of the southern alluvial plain of Iraq, where three sites were selected from the study soils

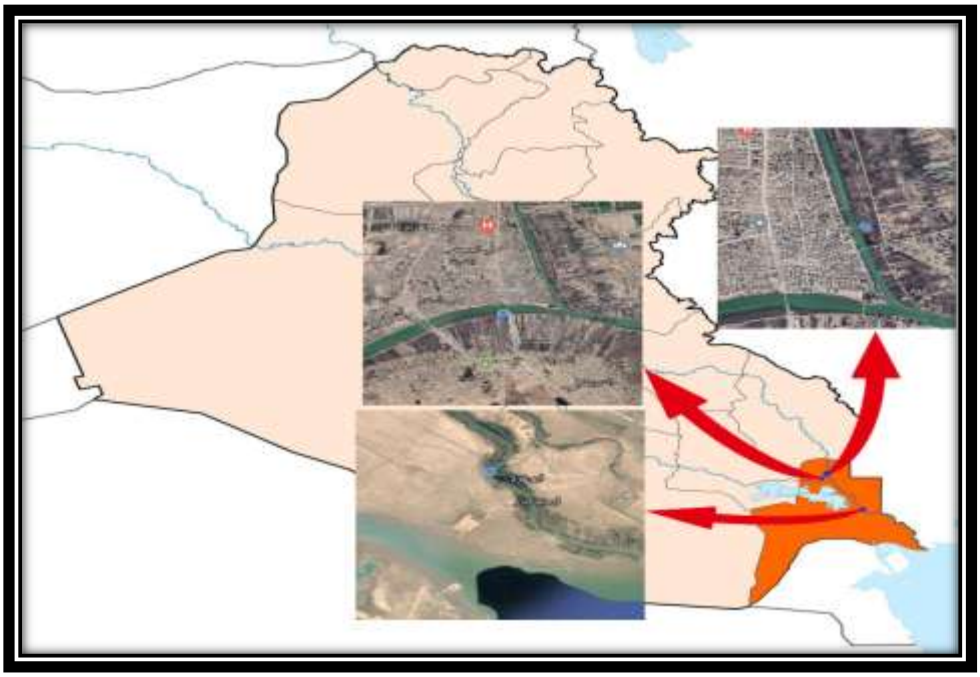

Figure (1): Map of Iraq showing the study areas.

Study sites are:

-The first site represents the sediments of the Tigris River in Basra Governorate / Qurna District (25-50 m from the Tigris River(

-The second site represents the sediments of the Euphrates River in Basra Governorate / Qurna District (25-50 m from the Euphrates River(

-The third site represents the Shatt al-Arab sediments in Basra Governorate / Al-Faw District (25-50 m from the Shatt al-Arab(

The soil samples that were studied for the depths (0-30 cm, 30-60 cm, 60-90 cm) were obtained homogeneously. Then, the samples were transported to the laboratory, where they were air-dried, and their balls were dismantled using a wooden hammer (in order to preserve the morphology of the minerals in them). Then, they were sieved with a diameter sieve. Its openings were (2) mm, and then the sand was separated by wet sieving using a sieve (53 micrometers), after which it was dried and kept in plastic boxes to conduct mineral analyses.

.2-2Mineralogical Analysis

X-ray diffraction analysis of sand separated by the powder method was conducted in the College of Science, Department of Earth Sciences, using an X-RD device, and the type

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of program used was (ICDD) to identify the nature of sand minerals.

Minerals were also counted, and minerals were counted using a point-counting method using a polarized light microscope by taking a slide on which Canada Balsam was placed, and separated sand was spread over it by sprinkling it lightly on this material with approximately 300 grains for each slide. Through it, the percentages of each mineral identified on these slides were calculated .

Results and Discussion

Content of heavy Minerals in sand separator of Tigris River sediment sample

Table (1) show the percentages of heavy Minerals in the sand separation in the sediments of the Tigris River. The most important Minerals that were distinguished were identified as the basic grade, which is the group of opaque minerals, as they were recorded in the sand separation for depths (0-30, 30-60, and 60-90). cm ratios of 40.6%, 40.7%, and 40.5%, respectively.

The Chlorite mineral group was also identified in the sand separation at depths (0-30, 30-60, and 60-90) cm, with a percentage of 9.3%, 7.4%, and 8.5%, respectively. The chlorite mineral group is considered a lamellar mineral that is characterized by its green or green color. Brown, which has a glassy or pearly luster, its origin in these sediments is due to the conditions suitable for its formation, as well as its inheritance from the source material. The percentages of heavy Minerals that are less resistant to weathering, represented by Pyroxene, were 7.2%, 7.2%, and 4.9% at the depths studied. At the same time, the amphiboles were identified, which are represented by the mineral Hornblende, which has a light green, transparent color, slightly tilted to brownish green, and has a glassy luster [10], as this mineral recorded a percentage of 4.6%, 5.7%, and 4.9% at the depths studied. Surface textures of quartz grains can provide crucial information to identify the associated transport mode, particularly in distinguishing aeolian from fluvial depositional environments [11 .[

The tests also diagnosed the presence of the Mica group of minerals among the heavy minerals of the sand separators of the Tigris River sediment samples.

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Table (1): Percentages of heavy Minerals in sand separators in Tigris River sediments

Heavy Minerals		sedimentary of the Tigris		
		0-30	**30-60**	**60-90**
Opaques		40.6	41.7	40.5
Chlorite		9.3	7.4	8.5
Pyroxene		7.2	7.2	4.9
Hornblende		4.6	5.7	4.9
Mica Group	Biotite	6.5	5.4	5.8
	Muscovite	5.3	4.5	5.6
Epidote		6.6	5.6	4.9
Zircon		5.4	5.9	5.5
Tourmaline		4.1	3.6	4.3
Rutile		3.5	3.7	4.7
Garnet		3.6	5.5	3.8
Staurolite		1.2	2.2	2.5
Kyanite		1.5	1.3	1.6
Others		0.6	0.3	2.5

This group of minerals is represented by the minerals Biotite and Muscovite, as the Biotite mineral recorded a percentage of 6.5%, 5.4%, and 5.8% for the studied depths, respectively. In contrast, the Muscovite mineral recorded a percentage. The amounts are 5.3%, 4.5%, and 6.5% for the depths studied. In general, Biotite is superior to Muscovite at all depths.

Ultrastable minerals, represented by (Tourmaline, Zircon, and Rutile), were identified in the heavy minerals of the sand separator at depths of (0-30, 30-60, and 60-90) cm. The percentage of Tourmaline mineral was 4.1%, 3.6%, and 4.3%, respectively. Zircon metal recorded a percentage of 5.4%, 5.9%, and 5.5%, while Rutile metal is characterized by its dark red color and clear cracks, and its percentage was 3.5%, 3.7% and 4.7%, respectively, for the depths studied. The heavy minerals of the sand separator also included Garnet, which recorded a percentage of 3.6%, 5.5%, and 3.8%. In contrast, the mineral Epidote was identified, recording a percentage of 6.6%, 5.6%, and 4.9%, respectively, at the depths studied.

Table (1) showed that the heavy minerals of the sand separator contain the mineral Staurolite, which was recorded in the Tigris sediment sample at a percentage of 1.2%, 2.2%, and 2.5%. In comparison, the percentage of Kyanite was 1.5%, 1.3%, and 1.6%, respectively. For the depths studied, the reason for the low percentage of Kyanite is due to the weak weathering of minerals from the parent rocks [12]. These results are somewhat consistent with what he found [13.[

Content of light Minerals in the sand separator of the Tigris River sediment sample

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Table (2) showed the percentages of light minerals in sand separations for depths (0-30, 30-60, and 60-90) cm in the soil of the Tigris River sediments. The results identified a group of quartz minerals that includes the monocrystalline type Monocrystalline Quartz and Polycrystalline Quartz, as they were The percentage of monocrystalline quartz is 32.8%, 36.3%, and 36.4%. In comparison, polycrystalline quartz has a percentage of 3.4%, 2.4%, and 2.6%, respectively, at the depths studied

Table (2): Percentages of light Minerals in sand separators in Tigris River sediments

Light Minerals		sedimentary of the Tigris		
		0-30	**30-60**	**60-90**
Quartz	Monocrystalline Quartz	32.8	36.3	36.4
	Polycrystalline Quartz	3.4	2.4	2.6
Feldspars	Potash Feldspar Microcline	3.4	3.5	4.9
	Plagioclase Feldspar	3.5	4.8	3.6
Rock Fragments	Carbonate Rock Fragments	36.2	31.8	32.4
	Chert Rock Fragments	6.9	7.3	5.3
	Mudstone Rock Fragments	4.4	3.2	3.2
	Evaporites (Gypsum)	3.6	2.5	3.7
	Igneous Rock Fragment	1.4	2.8	2.4
	Metamorphic Rock Fragments	2.5	3.3	3.6
Coated Grains by Clay		1.3	1.4	1.5
Others		0.6	0.7	0.4

The reason for the dominance of quartz minerals is attributed to the characteristics of quartz represented by its high resistance to weathering and its hardness. It did not contain cracks and was light in weight, which made it more solid and stable[14]. In general, there was a predominance of monocrystalline quartz compared to polycrystalline quartz in all sand separations at the three depths. These results are consistent with what was found [15.[

The results also showed the dominance of feldspar minerals, represented by Potash Feldspar Microcline and Plagioclase Feldspar, as these minerals recorded a percentage of 3.4 and 3.5% for the above feldspar minerals, respectively, at a depth of 0-30 cm. In comparison, they were recorded in (3.5 and 4.8%) (4.9 and 3.6%).) at depth (30-60 and 60-90) cm, respectively.

Table (2) showed the dominance of rock fragments that included carbonate rock fragments, chert rock fragments, metamorphic rock fragments, evaporites, igneous rock fragments, and mudstone rock fragments, as they constituted the rock fragments of the sand separator. At a depth of 0-30 cm (36.2, 6.9, 4.4, 3.6, 1.4, and 2.5%), while at a depth of 30-60 cm, the percentage of (31.8, 7.3, 3.2, 2.5, 2.8, and 3.3%) was for the rocks mentioned above. Successively, while at a depth of 60-90 cm, the proportions of (32.4, 5.3, 3.2, 3.7, 2.4, and 3.6%) were for the rocks mentioned above, respectively. All the carbonate rock pieces excelled at the depths studied, and this is consistent with what [16.[

The increase in the content of the Tigris sediments of the sand separator in the depths and its presence in close proportions is due to the process of dissolving those carbonate rock

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pieces and re-depositing them to form new forms of carbonate minerals. As for the flint stone, which is distinguished by its angular crystalline shape, and despite its presence in a high percentage in the Tigris River sediments of the sand separator, it is not. It has a significant impact on the chemical properties of soil [17]. The results showed the dominance of rock fragment minerals, then quartz, while the feldspar group and Plagioclase Feldspar outperformed Potash Feldspar Microcline in the first and second depths. These results are consistent with what was found by [18.[

.3-3Content of heavy Minerals in the sand separator of the Euphrates River sediment sample

Table (3) shows the percentages of heavy Minerals in the sand separator in the sediments of the Euphrates River. The most important Minerals that were distinguished were identified as the basic grade, which is the group of opaque minerals (Opaques), as they were recorded in the sand separator for depths (0-30, 30-60, and 60- 90) cm ratios of 41.2%, 40.3%, and 41.8%, respectively.

The Chlorite mineral group was also identified in the sand separation at depths (0-30, 30-60, and 60-90) cm, at a rate of 7.5%, 9.7%, and 7.3%, respectively. The Chlorite mineral group is considered a lamellar mineral that is characterized by its green or brown color. They have a glassy or pearly luster, while the percentages of heavy Minerals that are less resistant to weathering, represented by Pyroxene, were 5.5%, 7.8%, and 7.3% at the depths studied, while amphiboles were identified, which are represented by the mineral Hornblende, which is a light green, transparent color slightly tilted to Brownish green, with a glassy luster, this mineral recorded a percentage of 5.4%, 5.3%, and 5.2% at the depths studied. The tests also diagnosed the presence of the Mica group of minerals among the heavy minerals of the sand separators of the Euphrates River sediment samples. This group of minerals is represented by the minerals Biotite and Muscovite, as the Biotite mineral recorded a percentage of 4.6%, 6.2%, and 5.4% for the depths studied, respectively.

In contrast, the Muscovite mineral recorded a percentage. The amounts are 7.5%, 5.2%, and 6.4% for the depths studied. In general, Biotite is superior to Muscovite at the second and third depths.

Ultrastable minerals, represented by (Tourmaline, Zircon, and Rutile), were identified in the heavy minerals of the sand separator at depths of (0-30, 30-60, and 60-90) cm. The percentage of Tourmaline mineral was 4.8%, 4.1%, and 3.6%, respectively. Zircon metal recorded a percentage of 6.6%, 5.8%, and 5.2%, while Rutile mineral is characterized by its dark red color and clear cracks, and its percentage was 2.1%, 2.3% and 3.8%, respectively, for the depths studied.

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Table (3): Percentages of heavy Minerals in sand separators in Euphrates River sediments

Heavy Minerals		Euphrates River sediments		
		0-30	**30-60**	**60-90**
Opaques		41.2	40.3	41.8
Chlorite		7.5	9.7	7.3
Pyroxene		5.5	7.8	7.3
Hornblende		5.4	5.3	5.2
Mica Group	Biotite	4.6	6.2	5.4
	Muscovite	7.5	5.2	4.6
Epidote		6.7	5.6	6.3
Zircon		6.6	5.8	5.2
Tourmaline		4.8	4.1	3.6
Rutile		2.1	2.3	3.8
Garnet		4.7	4.2	5.5
Staurolite		1.6	1.5	2.2
Kyanite		1.5	1.6	1.4
Others		0.3	0.6	0.4

The heavy minerals of the sand separator also included Garnet, which recorded a percentage of 4.7%, 4.2%, and 5.5%. In contrast, the mineral Epidote was identified, recording a percentage of 6.7%, 5.6%, and 6.3%, respectively, at the depths studied. The results of Table (3) showed that the heavy minerals of the sand separator contain the mineral Staurolite, which was recorded in the Euphrates sediment sample at a percentage of 1.6%, 1.5%, and 2.2%. In comparison, the percentage of Kyanite was 1.5%, 1.6%, and 1.4%, respectively to the studied depths. These results are consistent with what was found by [19.[

Content of light Minerals in the sand separator of the Euphrates River sediment sample

Table (4) showed the percentages of light minerals in sand separations for depths (0-30, 30-60, and 60-90) cm in the soil of the Euphrates River sediments. The results identified a group of quartz minerals that includes the monocrystalline type Monocrystalline Quartz and Polycrystalline Quartz, as they were The percentage of monocrystalline quartz is 32.1%, 30.5%, and 33.7%. In comparison, polycrystalline quartz has a percentage of 1.7%, 2.1%, and 1.8%, respectively, at the depths studied. The reason for the dominance of quartz minerals is attributed to the characteristics of quartz represented by its high resistance to weathering and its hardness. In general, there was a predominance of monocrystalline quartz compared to polycrystalline quartz in all sand separators at the three depths. These results are consistent with what was found by [20.[

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Table (4): Percentages of light Minerals in sand separators in Euphrates River sediments

light Minerals		Euphrates River sediments		
		0-30	**30-60**	**60-90**
Quartz	Monocrystalline Quartz	32.1	30.5	33.7
	Polycrystalline Quartz	1.7	2.1	1.8
Feldspars	Potash Feldspar Microcline	3.9	4.8	3.6
	Plagioclase Feldspar	4.7	4.3	3.3
Rock Fragments	Carbonate Rock Fragments	32.6	34.8	33.9
	Chert Rock Fragments	8.7	6.4	7.4
	Mudstone Rock Fragments	4.8	5.5	3.8
	Evaporites (Gypsum)	2.4	2.6	3.7
	Igneous Rock Fragment	3.8	2.8	3.4
	Metamorphic Rock Fragments	3.6	3.2	2.6
Coated Grains by Clay		1.6	1.3	2.7
Others		0.1	1.7	0.1

The results also showed the dominance of feldspar minerals, represented by Potash Feldspar Microcline and Plagioclase Feldspar, as these minerals recorded a percentage of 3.9 and 4.7% for the above feldspar minerals, respectively, at a depth of 0-30 cm. In comparison, they were recorded at (4.8 and 4.3%) (3.6 and 3.3). %) at depth (30-60 and 60-90) cm, respectively. This agrees with [21], who confirmed during his study of the mineral composition and iron oxides of the sedimentary soils of the Tigris and Euphrates Rivers the dominance of carbonate rocks and then quartz minerals.

Table (4) showed the dominance of rock fragments that included carbonate rock fragments, chert rock fragments, metamorphic rock fragments, evaporites, igneous rock fragments, and mudstone rock fragments, as they constituted the rock fragments of the sand separator. At depth (0-30) (36.6, 8.7, 4.8, 2.4, 3.8, and 3.6%), while at depth (30-60), the percentage was (34.8, 6.4, 5.5, 2.6, 2.8 and 3.2% .(

For the rocks mentioned above succession, while at depth (60-90), it constituted a percentage of (33.9, 7.4, 3.8, 3.7, 3.4, and 2.6%) for the rocks mentioned above in succession. All rock pieces excelled in carbonate at all depths studied, and this is consistent with what was found by [17.[

The increase in the content of the Euphrates sediments of the sand separators in the depths and its presence in close proportions is due to the process of dissolving those carbonate rock pieces and re-depositing them to form new forms of carbonate minerals. As for the flint stone, which is distinguished by its angular crystalline shape and despite its presence in a high percentage in the Tigris River sediments of the sand separators, it is not. It has a significant impact on the chemical properties of soil [17]. The results showed the dominance of rock fragment minerals, followed by quartz minerals.

Content of heavy and light Minerals in sand separators of Shatt al-Arab sediments

Table (5) and Figure (6) show the percentages of heavy Minerals in the sand separator in the Shatt al-Arab sediments. The most important minerals that were distinguished were identified as the basic grade, which is the group of opaque minerals (Opaques), as they were recorded in the sand separator for depths (0-30, 30-60, and -60). 90) cm ratios of 35.3%, 34.2%, and 35.4%, respectively.

The Chlorite mineral group was also identified in the sand separation at depths (0-30, 30-60, and 60-90) cm, at a rate of 6.2%, 7.3%, and 7.5%, respectively. The chlorite mineral group is considered a lamellar mineral that is characterized by its green or brown color. Vitreous or pearly luster. The percentages of heavy Minerals that are less resistant to weathering, represented by Pyroxene, were 5.5%, 5.8%, and 5.7% at the depths studied. In contrast, the percentages of amphiboles were identified, which are represented by the mineral Hornblende, which has a light green, transparent color, slightly tilted to brownish green, and has a glassy luster. This mineral recorded a percentage of 6.1%, 6.1%, and 4.5% at the depths studied.

Table (5): Percentages of heavy Minerals in sand separators in Shatt al-Arab sediments

Heavy Minerals		Shatt al-Arab sediments		
		0-30	**30-60**	**60-90**
Opaques		35.3	34.2	35.4
Chlorite		6.2	7.3	7.5
Pyroxene		5.5	5.8	5.7
Hornblende		6.1	6.1	5.4
Mica Group	Biotite	5.3	6.4	4.6
	Muscovite	6.1	7.2	7.5
Epidote		4.4	3.6	5.1
Zircon		9.9	8.2	8.3
Tourmaline		8.5	7.6	7.5
Rutile		6.4	6.9	5.4
Garnet		2.8	2.6	3.4
Staurolite		1.6	2.2	1.5
Kyanite		1.3	1.6	2.3
Others		0.6	0.3	0.4

The tests also diagnosed the presence of the Mica group of minerals among the heavy minerals of the sand separators of the Tigris River sediment samples. This group of minerals is represented by the minerals Biotite and Muscovite, as the Biotite mineral recorded a percentage of 5.3%, 6.4%, and 4.6% for the depths studied, respectively. In contrast, the Muscovite mineral recorded a percentage. The amounts are 6.1%, 7.2%, and 5.7% for the studied depths. In general, the Muscovite mineral outperformed the Biotite mineral at all the studied depths.

Ultrastable minerals, represented by (Tourmaline, Zircon, and Rutile), were identified in the heavy minerals of the sand separator at depths of (0-30, 30-60, and 60-90) cm. The percentage of Tourmaline mineral was 8.5%, 7.6%, and 7.5%, respectively.

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Zircon metal recorded a percentage of 9.9%, 8.2%, and 8.3%, while Rutile mineral is characterized by its dark red color. Its percentage was 6.4%, 6.9%, and 5.4%, respectively, at the depths studied. The heavy minerals of the sand separator also included Garnet, which recorded a percentage of 2.8%, 2.6%, and 3.4%. In contrast, the mineral Epidote was identified, recording a percentage of 4.4%, 3.6%, and 5.1%, respectively, at the depths studied. The results of Table (5) showed that the heavy minerals of the sand separator contain the mineral Staurolite, which was recorded in the Shatt al-Arab sediment sample at percentages of 1.6%, 2.2%, and 1.5%. In comparison, the percentage of Kyanite was 1.3%, 1.6%, and 2.3%. Sequence to the studied depths.

Light minerals in the sand separation of the Shatt al-Arab sediment sample

Table (6) showed the percentages of light minerals in the sand separators for depths (0-30, 30-60, and 60-90) cm in the soil of the Shatt al-Arab sediments. The results identified a group of quartz minerals that includes the monocrystalline type Monocrystalline Quartz and Polycrystalline Quartz, as they were The percentage of monocrystalline quartz is 42.3%, 42.1%, and 41.7%. In comparison, polycrystalline quartz has a percentage of 2.5%, 1.7%, and 2.3%, respectively, at the depths studied. The reason for the dominance of quartz minerals is attributed to the characteristics of quartz represented by its high resistance to weathering and its hardness. In general, there was a predominance of monocrystalline quartz compared to polycrystalline quartz in all sand separations at the three depths.

The results also showed the dominance of feldspar minerals, represented by Potash Feldspar Microcline and Plagioclase Feldspar, as these minerals recorded a percentage of 3.3 and 4.7% for the above feldspar minerals, respectively,

Table (6): Percentages of light Minerals in sand separators in Shatt al-Arab sediments

Light minerals		Shatt al-Arab sediments		
		0-30	**30-60**	**60-90**
Quartz	Monocrystalline Quartz	42.3	42.1	41.7
	Polycrystalline Quartz	2.5	1.7	2.3
Feldspars	Potash Feldspar	3.3	4.0	3.1
	Plagioclase Feldspar	4.7	2.7	1.8
Rock Fragments	Carbonate Rock Fragments	18.8	22.9	21.3
	Chert Rock Fragments	6.7	5.6	8.2
	Mudstone Rock Fragments	4.2	6.8	5.6
	Evaporites (Gypsum)	10.5	8.3	9.5
	Igneous Rock Fragment	2.7	1.4	2.4
	Metamorphic Rock Fragments	2.4	2.3	1.6
Coated Grains by Clay		1.6	1.7	2.3
Others		0.3	0.6	0.2

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at a depth of 0-30 cm. In comparison, they were recorded at (4.0 and 2.7%) (3.1 and 1.8%).) at depth (30-60 and 60-90) cm, respectively, and this agrees with Al-Fatlawi, 2022), who, during his study of the mineral composition of different types of soils in Al-Qadisiyah Governorate, confirmed the dominance of quartz minerals and then carbonate rocks, rock fragments, feldspars, and limestone rocks. Respectively. Table (6) showed the dominance of rock fragments that included carbonate rock fragments, chert rock fragments, metamorphic rock fragments, evaporites, igneous rock fragments, and mudstone rock fragments, as they constituted the rock fragments of the sand separator. At depth (0-30) (18.8, 6.7, 4.2, 10.5, 2.7, and 2.4%), while at depth (30-60), the percentage was (22.2, 5.6, 6.8, 8.3, 1.4, and 2.3%). For the rocks mentioned above succession, while at depth (60-90), it constituted a percentage of (21.3, 8.2, 5.6, 9.5, 2.4, and 1.6%) for the rocks mentioned above in succession. All rock pieces excelled in carbonate at all depths studied, and this agrees with what was found by [22] and agrees with[23] who confirmed during their study to compare the mineral composition of sand separators in different gypsum soils from the Tigris and Euphrates deposits, the dominance of quartz minerals and then carbonate rocks, rock fragments, feldspars, and limestone rocks, respectively. As for the feldspar group, Plagioclase Feldspar outperformed Potash Feldspar Microcline in the second and third depths.

In certain depositional environments, such as hills, coasts, alluvial deposits, and rivers, heavy minerals have been extensively studied to regulate transport and origin signatures. The provenance or source rocks are typically determined using heavy minerals. Heavy mineral data constrain the mineralogical character of source terrains. Heavy minerals, a varied and non-genetic group, are found in detrital sediment and sedimentary rocks. They are not necessarily related but are defined by their effective separation technique. These minerals are parent rock minerals that have survived weathering. The heavy mineral assemblages in the samples indicate several possible source rock types: igneous, metamorphic, and sedimentary rocks [24,25[

Heavy mineral assemblages in fluvial sediments are controlled by source-rock lithology, hydraulic sorting, and chemical weathering [26,27]. In the upper-middle reaches of the Yellow River, sediment fluxes, desert sand supply, and tributary contributions create distinctive characteristics. Sediment accumulation occurs in the Yinchuan-Hetao plain of the upper reach [28], whereas erosion predominates in the middle reach [29]. In the upper reach, , amphibole content is higher than in the middle reach. This area is tectonically active, with bedrock exposed to weathering. Garnet increases downstream. Indicating significant detritus addition from local sources, especially the Mesozoic clastic deposits widely exposed in the Ordos Basin. Our data suggest that Cretaceous sandstones may represent a considerable sediment source [30]. Sediments are relatively enriched in unstable minerals [6], and assemblages resemble those of the upper reach due to tributary supply from the as indicated by the U–Pb age distributions of detrital zircons [30.[

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Conclusion

Based on the mineralogical analysis of sand separators from deposits of the Tigris, Euphrates, and Shatt al-Arab rivers, the findings offer a comprehensive understanding of the mineral composition and distribution within the sediment layers of these significant river deposits, highlighting both common and unique mineralogical characteristics. This information is crucial for further geological and environmental studies in the region. Opaque heavy minerals are the most common component, followed by chlorites and amphiboles. The abundance of these heavy minerals, such as those from igneous, metamorphic, and sedimentary rocks, indicates various source rocks. The sediments' maturity and stability are moderately stable, as evidenced by the assemblage of heavy minerals. Both the heavy and light parts of the mineralogical composition show that these are significant sources for the study areas in the river terraces and floodplains of the Mesopotamian Plain. Another source of these sediments is the aeolian deposits separated from sand dune fields in the studied area and outcrops of sedimentary formations in southeastern Iraq, as indicated by the presence of carbonate rock fragments. Silt loam texture dominates in Shatt Al-Arab sediments, while silty clay loam texture is prevalent in Shatt Al-Basrah sediments. Quartz, calcite, dolomite, feldspar, and halite represent the light minerals in the silt fraction. The clay minerals in Shatt Al-Arab sediments include montmorillonite-chlorite, kaolinite, palygorskite, and illite, with Shatt Al-Basrah sediments containing the same clay minerals with a small amount of montmorillonite. The light mineral contents in the sand fraction are primarily composed of quartz, feldspar, and rock fragments, with the main rock fragments consisting of carbonate, chert, igneous, metamorphic, mudstone, and evaporites (gypsum). The sediments' source is primarily the Tigris and Euphrates rivers, with minimal influence from tidal currents on the sediments of the Shatt Al-Basrah River.

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