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The Study of Mineral Composition and Free Iron Oxides in Sand Fraction for Tigris and Euphrates Rivers/Iraq

Haider J. Al-Ghabban[1] and Raid SH. Jarallah[2]

[1,2]College of Agriculture, University of Al-Qadisiyah, Al-Qadisiyah, Iraq.

[1]E-mail:agri.post22@qu.edu.iq
[2]E-mail: raid.jarallah@qu.edu.iq

Abstract. A study was carried out on the mineral composition and free Iron oxides of the sediments of the Tigris and Euphrates river. Two soils were selected representing the sediments of the Tigris (Al-Numaniyah) and Euphrates river (Al-Shamiya), and physical and chemical analyzes were conducted on them, the sand is separated by means of a sieve whose openings are (53 microns) in the presence and absence of oxides into sand separations (53-2000) micrometers, to prepare them for metallurgical examinations. The minerals of soil samples were examined by powder method using diffracted X-rays, and the results showed the following:The results of the diffracted X-ray examinations, the special results of the separated sand in the sediments of the Tigris river showed the presence of Quartz minerals (50.8 and 40.3%), Albite (13.3 and 10.3%) and Chlorite (3.3 and 8.3%) and Micas (5.4 and 6.4%) and Kaolinite (2.2 and 1.5%) for coarse and fine sand, respectively, and the percentage of free Iron oxides in coarse sand was (3.1%).and fine sand (2.9%), and the results of X-ray examinations of the sand separated in the sediments of the Euphrates river showed the presence of Quartz minerals (51.0 and 54.9%) and Albite (23.3 and 18.0%) and Chlorite (3.3 and 3.5%) , and Mica (5.4 and 3.3%) and Kaolinite (2.2 and 1.1%) and the percentage of free Iron oxides separated by coarse and fine sand was (2.4 and 1.8) respectively.

Keywords. Mineral Composition, Sand, Soil, Iron Oxides.

1. Introduction

Sand minerals are one of the natural resources spread in the earth's crust, which are products of the weathering processes of various source rocks, such as igneous, sedimentary or metamorphic, which differ in their mineral content from Quartz, Feldspar and others.The Feldspar minerals are one of the important components in sand minerals; of great importance in the study of the genetics and evolution of soils; so it is considered the important hereditary link in the evolution of mineral weathering processes, Its location in the middle of the chain of formative interactions gave it great importance in understanding the processes of soil evolution and weathering. The color is also one of the important and distinctive features of the initial minerals. Quartz and aluminous silicate are light in color, and they constitute most of the light sand minerals. While most of the heavy sand minerals form a group of manganese Iron minerals, which are distinguished by their dark-black color as a result of the presence of the ferrous ion within their mineral composition,[1].The study of the mineral content of sand separation is of great importance in understanding and inheriting soils genesis, estimating the extent of homogeneity in soil body materials and characterizing soil formation processes.Heavy sand minerals have a specific weight higher than 2.89 that are less corrosive in modern sediments compared to those derived from ancient sediments, and their study in sediments, especially sedimentary rocks, is geologically important. Heavy sand minerals can be divided as follows[2]:

- Dark minerals: They are the most important of the following minerals (Magnetite, Limenite, Pyrite, Hematite, Limonite and Lecoxcene).
- Micas minerals.
- Super-stable minerals: These are: (Zircon, Tourmaline and Rutile)
- Semi-stable minerals: represented by (Olivine).

As for the light sand minerals, it has a specific weight of less than 2.89, and it is the main part of the fine sand separated by the soil, as it expresses the weathering condition of these soils. The most important light sand minerals are (Quartz, Calcite, Aragonite, Dolomite, Gypsum, Halite and Borax) [2] The study conducted by [3] showed the mineral composition of some alluvial plain soils, where the results of X-ray examinations of the sand separated showed the presence of Chlorite, Mica and Kaolinite minerals, in addition to the presence of Quartz and Feldspar in the sediments of the Tigris and Euphrates rivers, also, X-ray examinations of the silt separated revealed the presence of Chlorite, Mica, Kaolinite, Quartz, Feldspar and small amounts of smectite, in addition to the presence of vermiculite. [4] found when studying three selected projects in the middle of the Iraqi alluvial plain, which are the project down the Diyala River, the Al-Latifiya project and the big Al-Musayyab project, He pointed out that heavy sand minerals showed the predominance of the Amphiboles group, followed by Opaque minerals, then Pyroxene and Biotite. The results also showed a severe decrease in the content of Zircon and Tourmaline minerals, or their absence sometimes in the percentages of heavy metals.

This was attributed to the nature and type of the origin rocks that make up the heavy metal group. As for the light sand minerals, the study showed the predominance of Quartz and Chert minerals, then Muscovite. This was attributed to the fact that the origin rocks that make up the light minerals are acidic igneous rocks and metamorphic rocks.

As for the Feldspars group, it was noted that Albite and Microcline were the most resistant minerals than the rest of the group.

Based on the above, the current study aims to: Study of the mineral composition of sand and free Iron oxides in the sediments of the Tigris and Euphrates rivers.

2. Materials and Methods

2.1. Preliminary Actions

The study region was chosen within the lands located in the governorates of Wasit and Al-Qadisiyah, and this region represents part of the southern alluvial plain of Iraq, where the two sites of soils were chosen :

- The first represents the sediments of the Euphrates river, Al-Qadisiyah governorate (Al-Shamiya District)
- The second represents the sediments of the Tigris river, Wasit governorate (Al Numaniyah District).

2.2. Field Procedures

Soil samples were obtained from the surface layer of the studied soil at a depth of (0-30 cm) in a homogeneous manner. Then the samples were transferred to the laboratory where they were dried pneumatically and their rounds were dismantled using a wooden hammer (in order to preserve the morphology of the minerals in it) and then sieved with a sieve with holes diameter (2) mm. They were collected in plastic storage containers to prepare for chemical, physical and mineral analyzes, Table (1).

Table 1. Some chemical and physical characteristics of the two study soils.

Measured adjective		measuring unit	Sedimentation sample of the Tigris river	Euphrates River sedimentation sample
Electrical Conductivity EC 1:1		ds m^{-1}	3.26	5.90
pH 1:1		-	8.24	8.33
Organic matter O.M		gm.kgm^{-1}	8.6	6.9
carbonate minerals			233.1	301.0
Soluble calcium Ca^{+2}		mEq/L^{-1}	14.24	13.12
Soluble Magnesium Mg^{+2}			9.24	8.21
dissolved sodium Na^{+}			2.23	1.89
Soluble potassium K^{+}			1.20	1.02
Dissolved chlorine Cl^{-1}			21.11	20.03
Dissolved bicarbonate HCO_3^{-1}			1.10	1.40
CO_3			Nil	Nil
Soil separations	sand	gm kgm soil $^{-1}$	588	608
	clay		172	112
	silt		240	280
Tissue class		-	sandy mix	sandy mix
cation exchange capacity		Cmol+kg^{-1}	8.21	6.18
bulk density		gm / cm^3	1.17	1.13
free Iron oxides		gm.kgm^{-1}	28.94	30.71

2.3. Particle Size Distribution

The relative distribution of soil separations was estimated by the hydrometer method mentioned in [5] to determine the proportions of soil separations, as the separations (sand, silt, clay) were calculated, after removing the binding materials represented by calcium carbonate, by adding acidified sodium acetate pH = 5, and removing the organic matter by using hydrogen peroxide H_2O_2 at a concentration of 30%, with the addition of the dispersant substance chalcone, Sodium hexa metaphosphate for the purpose of dispersing those particles.

2.4. Bulk Density

In the Core sample, according to the method mentioned in [5].

2.5. Chemical Analyzes

- Electrical conductivity (EC): It was measured in a 1:1 soil-water suspension using an EC-meter [6].
- Soil reaction degree (PH): It was measured in a 1:1 water-soil suspension using a PH-meter. [6].
- Total carbonates minerals :- They were estimated by calcimeter using 1standard hydrochloric acid, according to what was stated by [7].
- Organic matter (O.M):- was determined by wet oxidation method by potassium dichromate according to [8], method described in [9].
- The exchange capacity of positive ions and positive ions exchange (CEC): - The exchange capacity of positive ions was determined by saturation with 1 molar sodium acetate with reaction number pH = 8.2 ,the exchanged positive ions, Na+, were extracted using 1 standard ammonium acetate, and potassium was extracted with a solution of calcium chloride (0.5M), and they were estimated using a flame photometer, and the mutual calcium and magnesium (Ca^{+2}, Mg^{+2}) were estimated by titration with Fresnet according to [6].
- Soluble ions: Measured in a soil suspension: water 1:1
- Calcium and Magnesium: They were determined by titration with fersnet (Na2 - EDTA) 0.01 N, according to the method mentioned in [6]**.**

- Sodium and potassium: They were estimated using a flame photometer according to the method mentioned in [6].
- Carbonates and bicarbonates: They were determined by titration method with dilute sulfuric acid (0.01)N using the index of phenolphthalein in the case of carbonates, and methyl orange in the case of bicarbonates according to [10].
- Dissolved chlorides: They were determined by volumetric method, by titration with silver nitrate (0.01 N) using potassium chromate index according to [10].

2.6. Mineral Analysis
Diagnosis of minerals separated sand by powder method using X-ray diffraction.
The separated sand was taken with its coarse and fine parts, with and without free Iron oxides, and for both sediments of the Tigris and Euphrates rivers, then it was examined by X-diffraction by powder method to diagnose the predominant minerals and their ratio.
The percentage of free Iron oxides (Magnetite and hematite) was calculated from X-diffraction.

3. Results and Discussion

3.1. X-ray Diffraction in the Sediments of the Tigris River
The results of the X-ray assays shown in Figures (1, 2, 3 and 4) of the sand separation of the sedimentation of the Tigris river, including R_2O_3 removed and not removed, showed the identification of Quartz mineral thcoarse X-diffraction and for the two removed and non-removed samples, where the ratio of Quartz for the separation of coarse and fine sand was recorded (50.8 and 40.3%) for the removal sample. In the presence of R_2O_3, Quartz metal recorded a percentage of (45.5% and 46.8) respectively. It was noted from the results that this mineral is present in a higher quantity in the coarse sand separated.
Albite mineral was detected in the fine and coarse sand separated, as it recorded a percentage of (13.3 and 10.3%) in the removal sample compared to the sample containing R_2O_3, which recorded a percentage of (11.6 and 9.1%) respectively. These results show that this mineral predominates in the separated coarse sand.
The below figures also showed the appearance of diffraction (14.7) Angstrom, which represents the mineral Chlorite in varying proportions in the fine and coarse sand separated of the Tigris sediment sample that amounted to (3.3 and 8.3%) for the removal sample compared to the sample containing R_2O_3 which recorded (1.3 and 2.8%) respectively , it was noted from the results that this mineral is present in a higher quantity in the fine sand separated.
The results of the X-ray diffraction examination also showed the appearance of diffraction (10.0) Angstrom representing the Mica mineral, and a percentage of (5.4 and 6.4%) was recorded for the removal sample in the coarse and fine sand separated, while it was recorded in the sample containing R_2O_3 (3.4 and 3.3%) respectively, and this indicates that increasing the proportion of this mineral in fine sand separated compared with coarse sand. This is consistent with the study .
The results showed the presence of Kaolinite thcoarse the diffraction of (7.2) Angstrom, and a percentage of (2.2 and 1.5%) was recorded in the fine and coarse sand separated, and this indicates an increase in the percentage of this mineral in the coarse sand separated compared with the fine sand.
From the above results, we find the predominance of Quartz and Albite minerals in the coarse sand separation, and the predominance of Chlorite, Mica and Kaolinite minerals in the fine sand separation, and this is consistent with what was founded by (Jarallah, 2000){3}, and the percentage of free Iron oxides in the coarse sand was (3.1%), while in the fine sand it reached (2.9%) in the form of the minerals Magnetite and hematite, and this indicates their presence in a larger amount in the coarse sand separated , this is consistent with what was found by [11] in his study of the values of oxides in sand separation.

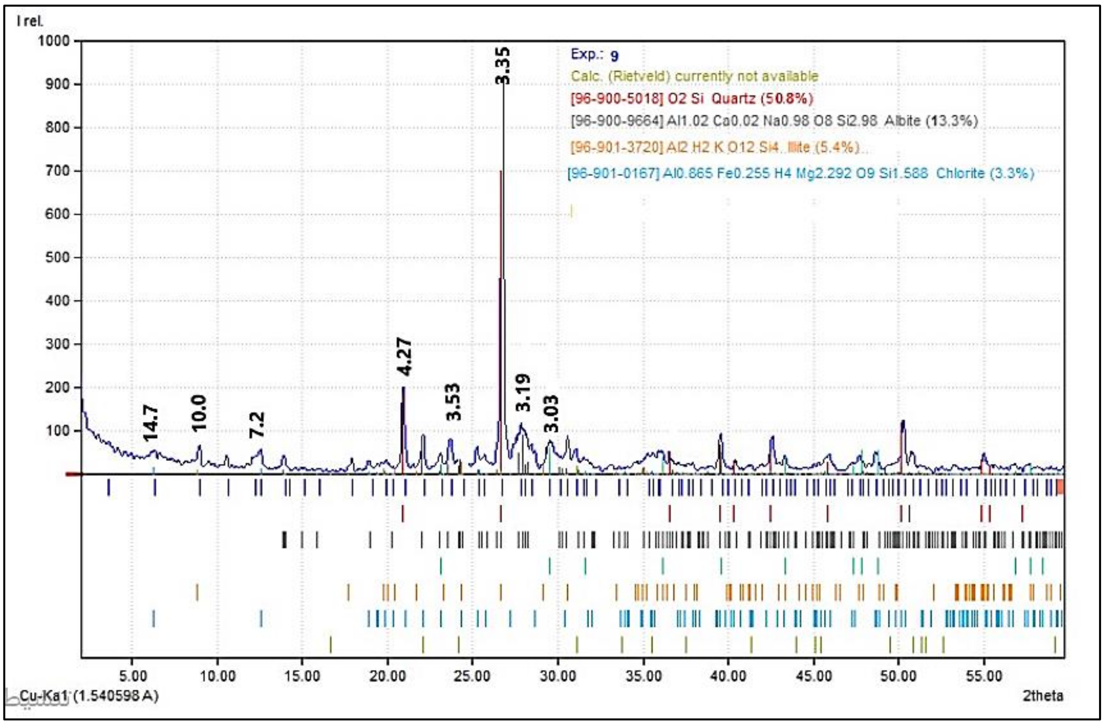

Figure 1. X-diffraction of coarse sand from the sediments of the Tigris river (removal of oxides).

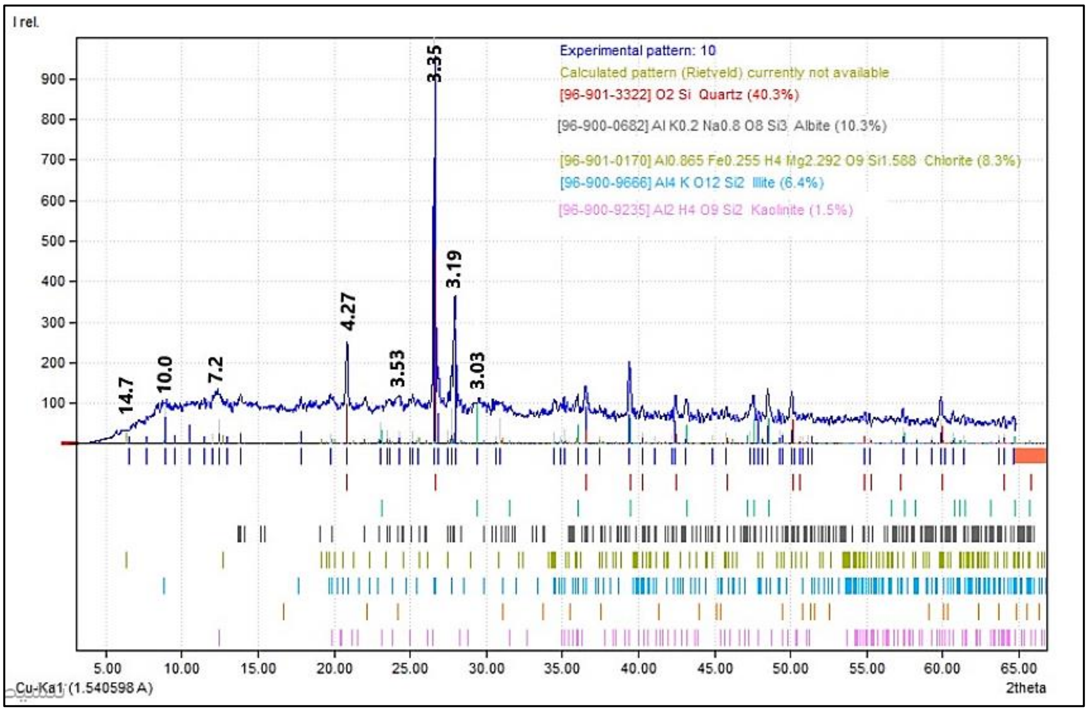

Figure 2. X-diffraction of fine sand from the sediments of the Tigris River (removal of oxides).

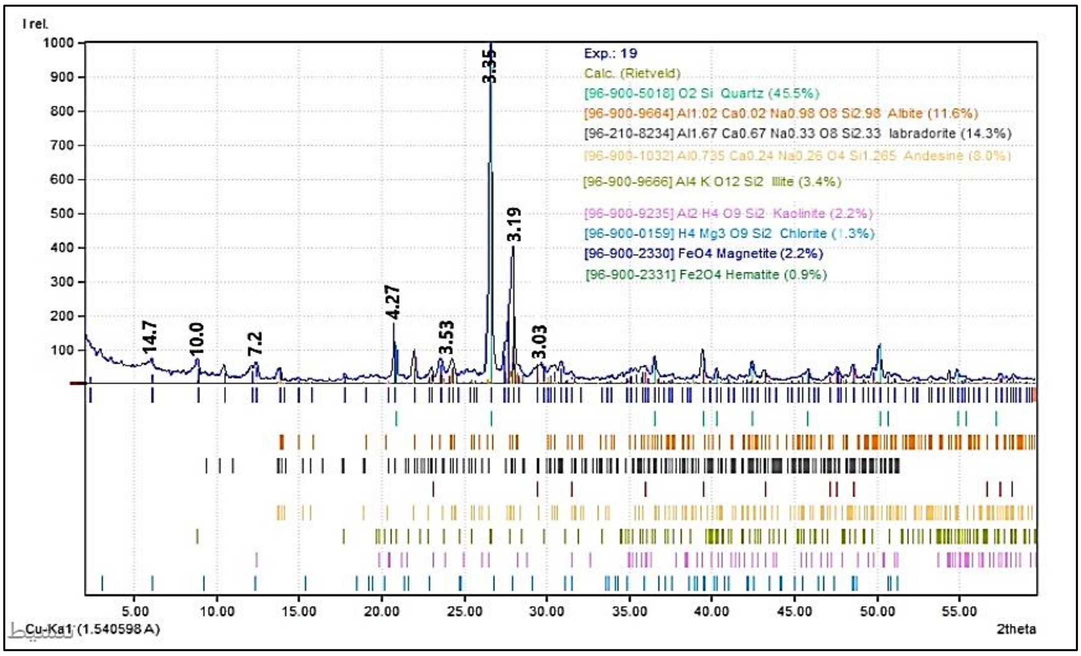

Figure 3. X-diffraction of coarse sand from the sediments of the Tigris River (with R_2O_3).

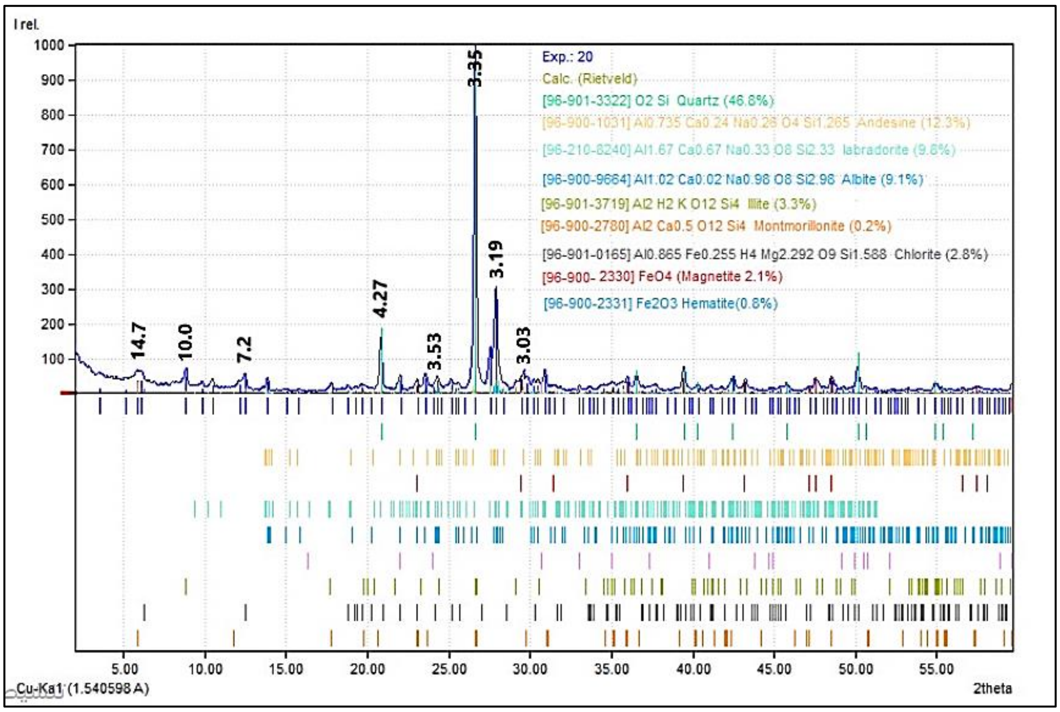

Figure 4. X-diffraction of fine sand from the sediments of the Tigris River (with R_2O_3).

3.2. X-ray Diffraction in the Sediments of the Euphrates River

The results of the X-ray examinations shown in Figures (5, 6, 7 and 8) are shown of the sand separation of the sedimentation of the Euphrates River, including removed R_2O_3 and not removed, showed the identification of Quartz mineral coarse X ray-diffraction and for the two removed and non-removed samples, where the ratio of Quartz for the separation of coarse and fine sand was recorded (51.0 and 54.9%) for the removal sample, in the presence of R_2O_3, Quartz metal (40.5 and 40.8) was recorded respectively, and it was noted from the results that this mineral is present in a higher quantity in the fine sand separated. This is the opposite of what was found in the sediments of the Tigris river.

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Albite mineral was detected in the fine and coarse sand separated of the Euphrates sediment sample, as it recorded a percentage of (23.3 and 18.0%) in the removal sample compared to the sample containing R_2O_3, which recorded a percentage of (21.6 and 9.1%) respectively. These results show that this the mineral predominates in the coarse sand separated, as the above figures showed the appearance of diffractions that represent the presence of Chlorite mineral in varying proportions in the coarse and fine sand separated of the Euphrates river sediment sample, which amounted to (3.3 and 3.5%) for the removal sample compared to the sample containing R_2O_3 which recorded (0.3 and 2 .8%) respectively, and it was noted from the results that this mineral is present in a higher quantity in the fine sand separated.

The results of the X-ray diffraction examination also showed the appearance of diffraction 10 Angstroms representing Mica mineral, and a percentage of (5.4 and 3.3%) was recorded for the removal sample in the coarse and fine sand separated, while it was recorded in the sample containing R_2O_3 in the coarse and fine sand separated (3.4 and 4.3%) respectively. This indicates the predominance of this mineral in the fine sand separated.

The results also showed the presence of the mineral Kaolinite thcoarse the diffraction of (7.2) Angstrom, and a percentage of (2.2 and 1.1%) was recorded in the coarse and fine sand separated, and this indicates an increase in the percentage of this mineral in the coarse sand separated compared with the fine sand.

From the above results, we find the predominance of Albite and Kaolinite minerals in the coarse sand separation, and the predominance of Quartz, Chlorite and Mica minerals in the fine sand separation, and this is consistent with what was found [3],and the percentage of free Iron oxides in coarse sand (2.4%) and fine sand (1.8%)) (in the form of Magnetite mineral) and these ratios agreed with the sediments of the Tigris river in its dominance in the coarse sand separated and these values were close to what was found by [3], who found that their values were (2.07 and 2.92) gm $Fe_2O_3.kg^{-1}$ in sand separation in general for the sediments of the Tigris and Euphrates rivers, respectively.

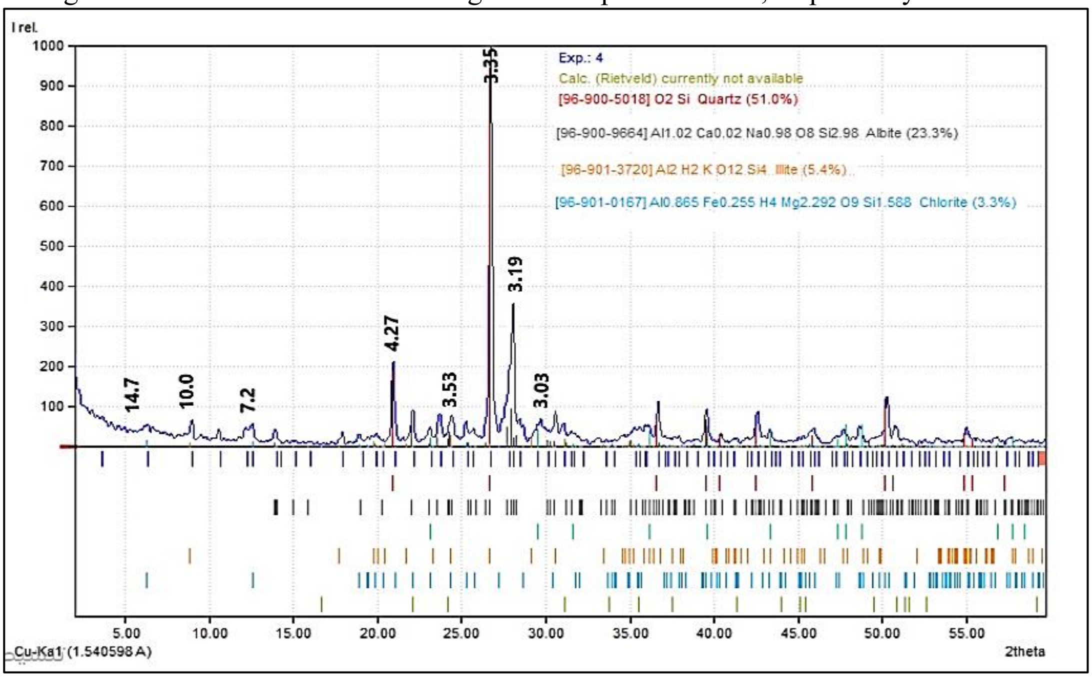

Figure 5. X-diffraction of coarse sand from the sediments of the Euphrates River (removal of oxides).

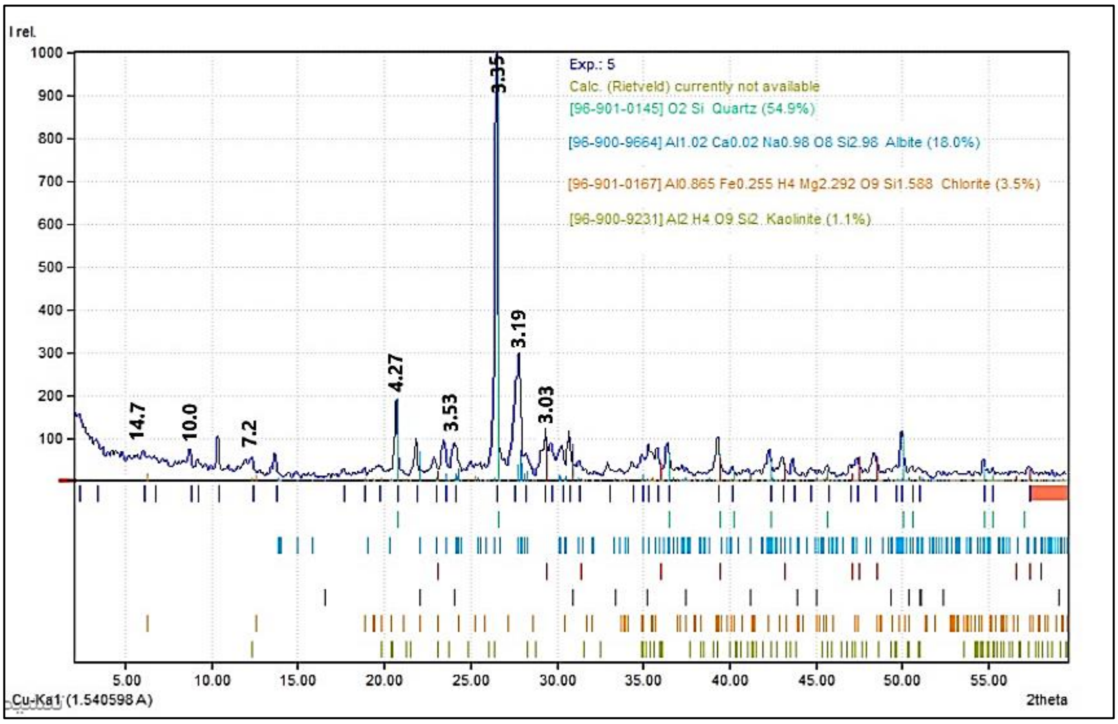

Figure 6. X-diffraction of fine sand of Euphrates sediments (removal of oxides).

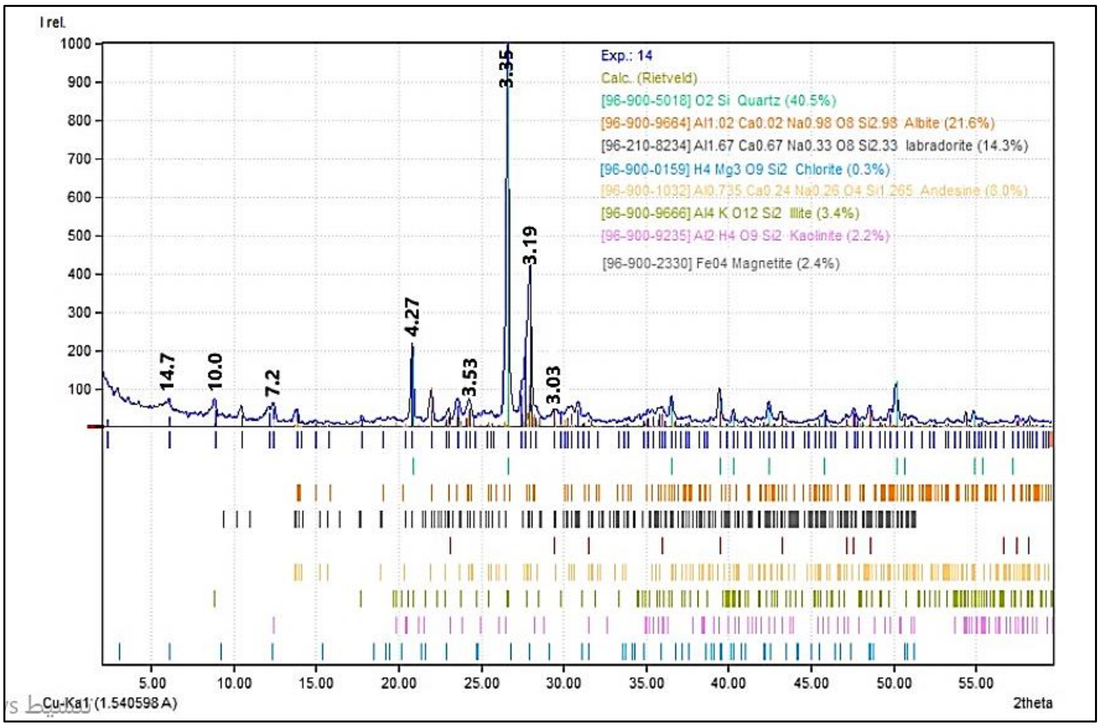

Figure 7. X-diffraction of coarse sand from the sediments of the Euphrates river (with R_2O_3).

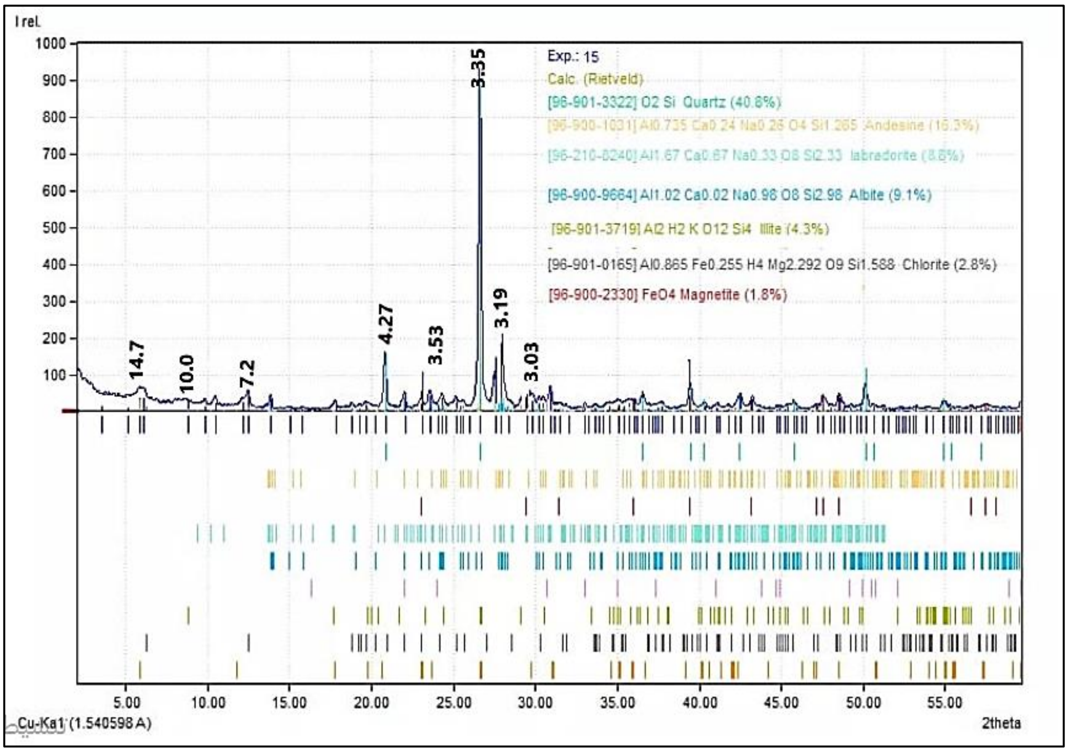

Figure 8. X-diffraction of fine sand from the sediments of the Euphrates River (with R_2O_3).

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