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Mineralogy of Recent Sediments of AL-Teeb River Basin East Missan Governorate Southeastern Iraq

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Abstract

The main aim of this research is to define the mineralogical composition of recent sediments deposited around the Al-Teeb river basin in eastern Missan, trying to determine the provenance or the source of these sediments.

The study area represents the southeastern edge of the Mesopotamian Plain and is part of it. Quaternary deposits cover most of the area. It is clayey with old sea and river deposits and part of aeolian deposits.

These sediments cover 95% of the study area, while the older rocks, which date back to the Tertiary (Late Miocene – Pliocene), exposed in the area east and northeast of the Al-Teeb area, made up hills which back to the undifferentiated Pliocene Mukdadiya and Bai-Hassan formations.

The light components of these sediments consist mainly of quartz, feldspars (potash and plagioclase feldspar), sedimentary rock fragments (carbonate rock fragments, chert rock fragments, evaporates fragments), igneous rock fragments, and metamorphic rock fragments

The heaviest minerals are opaque, amphiboles, pyroxenes, chlorite, epidotes, biotite, garnet, muscovite, zircon, kyanite, staurolite, and rutile.

These sediments are typically formed by sedimentary rocks (single or many cycles), low and high-rank metamorphic rocks, acidic and basic igneous rocks, and pegmatite rocks.

The high percentage of opaque heavy minerals in clastic sediment refers to unstable clastic sediments. The stability issue to the areas during the study shows that there are significant variances over the several places, indicating dissimilar sources and types of source rocks

Keyword: Recent Sediments, Bai-Hassan Formation, Light Minerals, Provenance

معدنية الرواسب الحديثه لحوض نهر الطيب شرق محافظة ميسان جنوب شرق العراق

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قسم علم الأرض، كلية العلوم، جامعة بغداد، بغداد، العراق

الخلاصه

الهدف الرئيسي لهذا البحث هو تحديد التركيب المعدني للترسبات الحديثه المترسبة حول حوض نهر الطيب شرق محافظة ميسان، لتحديد أصل أو مصدر هذه الرواسب.

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تمثل منطقة الدراسة الحافة الجنوبية الشرقية للسهل الرسوبي وإنها جزء منه، تغطي رواسب العصر الرباعي معظم المنطقة، هذه الرواسب عبارة عن اطيان ورواسب نهرية وبحرية قديمة وجزء من ترساب ريحيه. هذه الرواسب تغطي حوالي 95% من منطقة الدراسة، بينما الصخور القديمة تعود الى العصر الثلاثي، تتكشف في شرق وشمال شرق منطقة الطيب، تكون عبارة عن تلال تعود لتكاوين مختلفه مثل المقدادية وباي حسن.

المكونات الخفيفة الهذه الرواسب تشمل الكوارتز والفلديسبار البوتاسي والبلاجيوكليس وقطع الصخور الرسوبيه (الكربوناتية وقطع الصوان وقطع من المتبخرات) وقطع من الصخور النارية والمتحولة

المعادن الثقيلة هي في الغالب المعادن المعتمة ، كلوريت ، بايروكسينات ، أمفيبولات ، إبيدويت ، زركون ، كارنت ، معادن المايكا (موسكوفايت ، بايوتايت) ، كيانيت ، شتوروليت ، روتيل.

مصدر هذه الرواسب هو مشتق بالمقام الاول من الصخور الرسوبيه (دورات مفرده او متعدده), صنف عالي او واطئ من الصخور المتحوله , صخور نارية حامضية وقاعدية.

تشير النسبة العالية من المعادن الثقيلة المعتمه في الرواسب الفتاتية إلى الرواسب الفتاتية غير المستقرة. الاستقرارية في المناطق خلال الدراسة أن هناك تباينات كبيرة على عدة أماكن ، مما يشير إلى اختلاف مصادر وأنواع صخور المصدر

Introduction

The study area is considered an important task to determine the provenance and kinds of the sediments and minerals to recent sediments for Al-Teeb river basin; it is part of the Mesopotamian Plain and covers an area of 1191 km2. Al-Teeb is a seasonal river with a maximum length of about 60 km and passes through the study area, which flows from Iran territory, and ends in Hor Al-Snnaf outside the boundaries of the study area**.**

AL-Teeb river basin located east of Missan Governorate in southeastern Iraq, geological Formations that are outcrop in the north-east part of the study area are Bai-Hassan and Mukdadiya formations, which represent Tertiary deposits. While deposits of Quaternary cover the rest of the area [1].

AL-Teeb river basin is located within the unstable shelf [2]. This represents the main portion of the Mesopotamian Plain, characterized by shallow subsurface longitudinal anticlines separated by syncline with the direction of the north west- south east with several faults associated with these folds within the area between Al-Teeb and Sheikh Faris [3].

Fifteen recent sediment samples deposited near the Al-Teeb river were collected through two field trips. This research aims to determine the main types of sediments in the studied area and the mineralogy of these sediments.

Site of Studied Area

The study area is located northeast of Missan in southeastern Iraq. between the latitudes (32° 15' 00'' - 32° 30' 00'' N) and longitudes (46° 55' 00''- 47° 25' 00''E). The boundary of the study area represents the Iraqi-Iranian border in the east and includes an area of 1191 km2. The rise of the topography varieties between (14- 200 m) above sea level. The land surface in the central part of the study area is relatively flat, and Himrin hills limit it in the northeast. Al-Teeb River runs through the study area, which comes from Iranian land (Figure1).

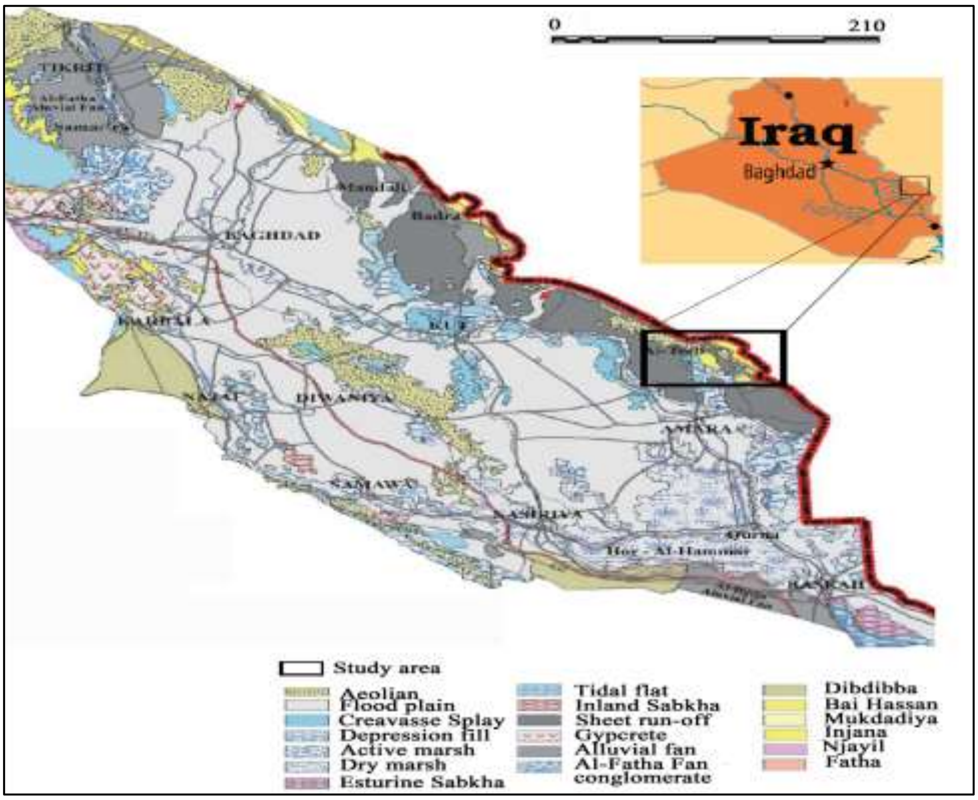

Figure 1: Location map of study area [4].

Figure 2: AL-Teeb river passes through the studied area.

Figure 3: Sample collection from the studied area

Geology of Studied Area

Most of the Al-Teeb River Basin in the Iraqi territory is covered by Quaternary deposits that consist of sands, silts and silty clays, whereas the Tertiary rocks are restricted to the eastern and northeastern parts of the area. The Quaternary deposits represent about 72%, while Tertiary sediments extend over 28%. The stratigraphic column in the study area is represented by undifferentiated Mukdadiya (Late Miocene – Pliocene) and Bi Hassan (Upper Miocene - Pliocene) formations. Mukdadiya Formation consists of monotonous sequences of interbedding of claystone and sandstone with some siltstone intercalation. The sandstone beds very often contain pebbles with different shapes and lithologies. Therefore, they are considered typical freshwater. Bai Hassan Formation is composed of conglomerate, claystone and sandstone interbedding [1]. In addition, several major normal and thrust faults are identified in the study area [5] (Figure 4).

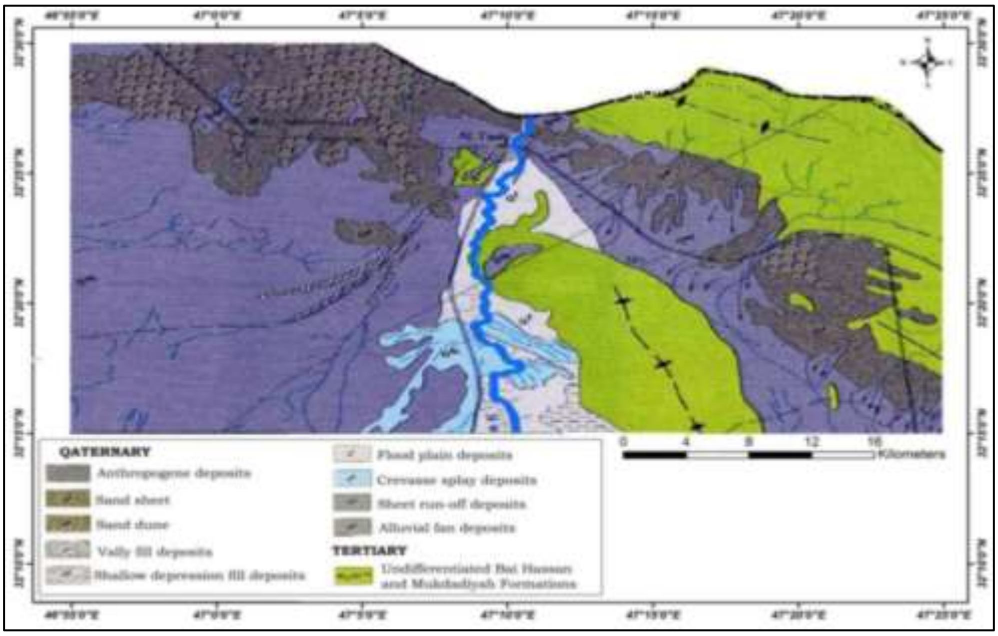

Figure 4: Geological map of the studied area, [1]

Methods of Study

Fifteen samples were collected from eight stations of recent sediment that was deposited around the Al-Teeb river. Two field works (December 2019 and August 2021) are done. The goal of this research is to determine the main types of sediments in the studied area and determine the mineralogy of these sediments. The fine and very fine size fractions were sorted into heavy and light minerals using the bromoform liquid. The mineralogical configuration of the heavy and light minerals was studied using a polarizing microscope and the usual counting technique.

Result and Discussion

1- Light Components

The light mineral fraction composes 95.5% of the total mineralogy. The light components (%) in the studied samples are summarized in Tables 1 and Figure 5.

Table 1: Light minerals (%) of Al-Teeb river basin.

Light Components	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8
Monocrystalline Quartz	20.78	19.60	21.04	20.74	22.96	23.80	24.18	26.25
Polycrystalline Quartz	3.18	2.94	3.14	3.74	2.62	2.33	3.28	2.28
Potash Feldspar Orthoclase	3.80	4.02	3.52	3.68	3.16	3.40	3.15	3.38
Potash Feldspar Microcline	2.60	2.26	2.24	2.82	2.40	2.63	3.00	2.35
Plagioclase Feldspar	3.25	3.14	3.30	3.58	3.18	3.63	3.98	3.80
Carbonate R.F.	35.60	35.48	34.70	33.44	34.00	31.70	30.45	31.75
Chert R.F.	7.57	7.78	7.94	8.14	7.06	7.63	7.05	8.08
Igneous R.F.	3.68	4.46	3.64	3.78	3.34	3.58	2.85	3.35
Metamorphic R.F.	3.6	3.64	3.38	2.86	3.34	4.25	3.13	2.70
mudstone R.F.	5.42	5.36	6.26	6.34	5.82	4.98	6.83	4.35
Evaporates	7.38	7.66	7.46	7.28	6.22	6.30	8.43	7.78
Coated Grains by Clay	2.57	2.70	2.74	2.56	3.26	2.33	2.48	2.75
Others	0.97	0.96	0.90	1.02	1.20	0.90	0.98	1.10

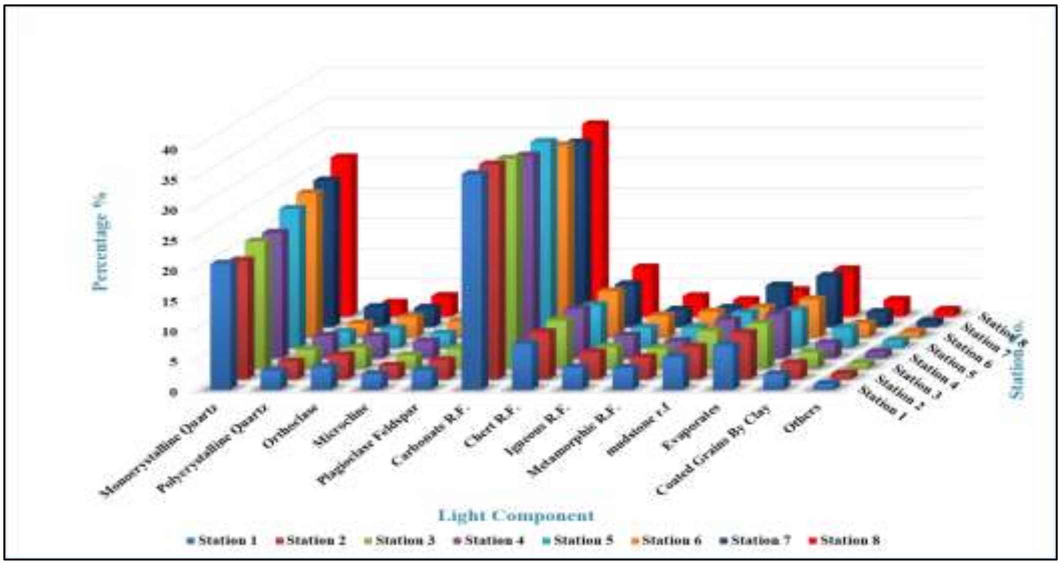

Figure 5: Bar-chart represents the ratios of light components in the studied samples.

Most quartz grains are monocrystalline, without inclusion and a straight extinction. Small amounts of polycrystalline and chert fragments can be found; therefore, the total average silica content is higher than 25.31% of the light fraction. The percentage of the total average of feldspars is 9.53% Plagioclase, microcline, and orthoclase are all part of the light fraction. Many of these grains have been changed to different forms and shapes. Carbonate rock fragments make a total average of 33.39% and are found mostly of calcite and dolomite as older formation rock fragments with distinct micritic and recrystallized components. Clear crystals and biogenic shell fragments are also present to a lesser extent. Evaporites Percentage is 6.15% of the light segment, mostly comprised of gypsum and anhydrite. The igneous and metamorphic rock fragments are 5.43%. The studied samples contain about 5.19% mudstone rock fragments. Coated grains by clay make up 2.7.% of studied samples. The identification of these grains is difficult due to this coated clay. These components are shown in Figure 6.

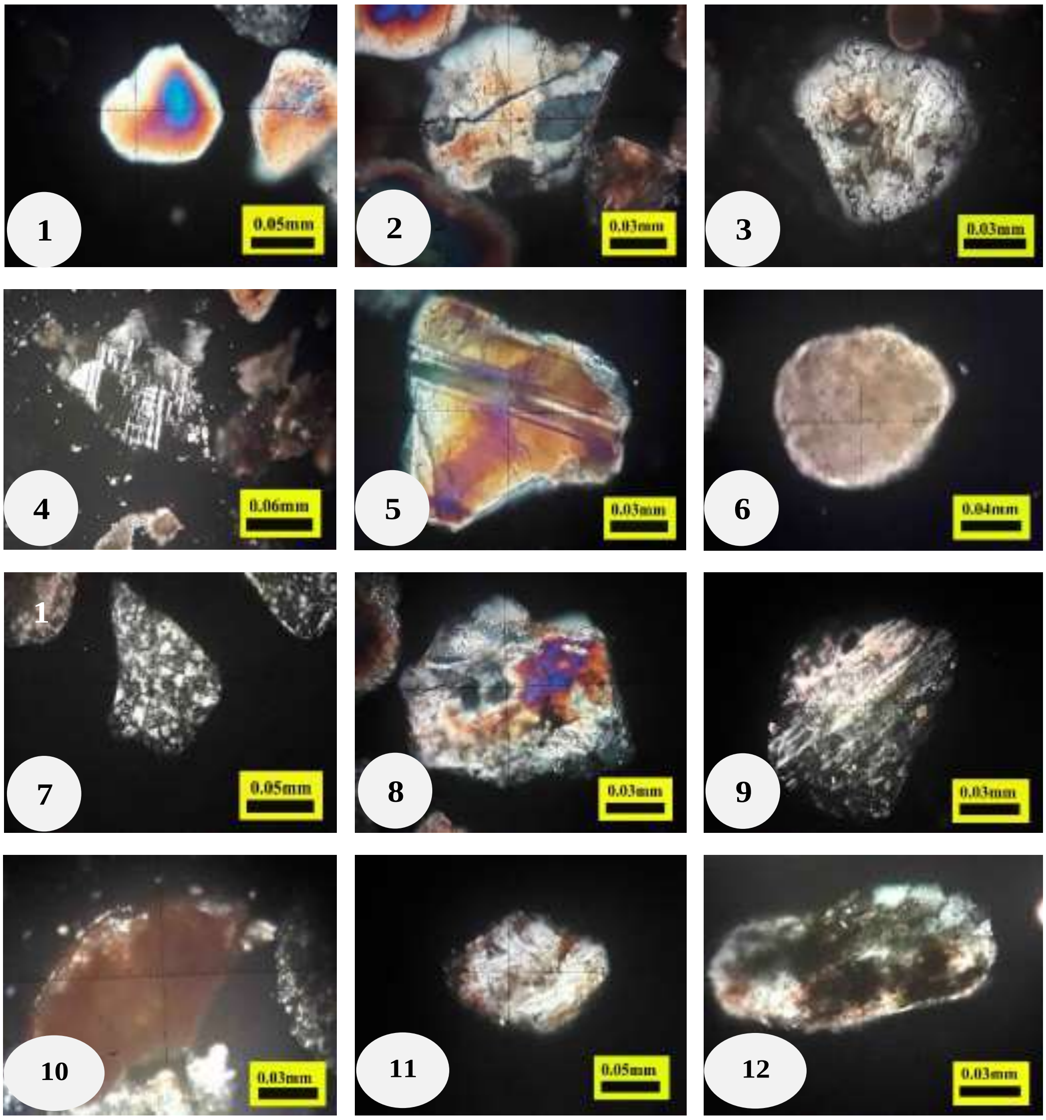

Figure 6: Images of the light minerals in the studied samples. 1; rounded monocrystalline quartz, 2: sub-rounded polycrystalline quartz, 3: orthoclase potash feldspar, 4: microcline potash feldspar, 5: plagioclase feldspar, 6: carbonate rock fragment, 7: angular chert rock fragment, 8: igneous rock fragment, 9: metamorphic rock fragment, 10: mudstone rock fragment, 11: evaporates fragment (Gypsum grain), 12: grain coated by clay.

2- Heavy Minerals

The heavy minerals found in 15 samples from eight stations of recent sediments of the Al-Teeb river basin were resolute in applying them to determine the source rock types, the source area's nature, and the mineralogical composition stability of these sediments. The heavy mineral analysis separation process was followed after ([6] [7] [8] [9]). The heavy minerals in the samples were calculated using a point counter mechanical stage and the method of [10].

The major component of the analyzed samples' heavy mineral residue is opaque minerals with a regular 36.76% and non-opaque minerals with a regular 63.24%. The non-opaque mineral accumulation is mainly collected of chlorite 7.42%, pyroxenes composed of both orthopyroxene and clinopyroxene 6.37%, amphiboles composed of hornblende, glaucophane, and tremolite 7.02%, (mica: biotite and muscovite) 9.81%, zircon 7.54%, tourmaline 5.1%, epidote group 5.91%, rutile 4.5%, kyanite 2.2%, the percentages of heavy minerals were shown in Table 2 (Figure7). The shape of these minerals varies from rounded to angular, while the habit varies from prismatic to flaky (Figure8).

Table 2: Percentages of heavy minerals in the studied samples

Heavy minerals	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8
Opaques	38.23	38.18	39.34	38	36.22	35.03	34.7	34.35
Chlorite	8.35	7.8	8.64	7.16	7.68	6.1	6.58	7.05
Zircon	6.97	7.68	5.34	6.82	7.64	8.7	8.23	8.93
Garnet Group	4.48	4.56	4.52	4.34	4.62	5.2	4.83	5.65
Orthopyroxene	2.4	2.56	2.64	2.62	2.58	2.95	2.65	2.13
Clinopyroxene	3.37	3.58	3.78	3.8	3.93	3.93	3.7	4.33
Hornblende	4.57	4.02	4.3	5.3	4.24	5.25	3.9	4.4
Tremolite	1.32	1.33	1.28	1.23	1.15	1.3	1.38	1.47
Glaucophane	1.28	1.24	1.03	1.2	1.13	1.2	1.28	1.4
Muscovite	6.17	5.28	5.92	6.08	6.26	5.65	5.68	5.35
Biotite	3.92	4.2	4.12	4.16	4.22	3.68	4.08	3.75
Tourmaline	3.93	4.68	4.02	4.28	5.24	5.5	6.5	6.6
Epidote Group	5.78	5.72	6.94	5.88	5.62	5.4	6.48	5.45
Rutile	3.95	3.94	4.02	3.92	4.24	4.95	5.8	5
Kyanite	2.28	2.28	2.42	2.3	2.18	2.1	2.05	2.1
Staurolite	2	2.02	2.08	2.52	3.12	2.88	2.7	2.18
Others	1.05	1.2	1.2	1.1	1	1.4	1.2	0.8

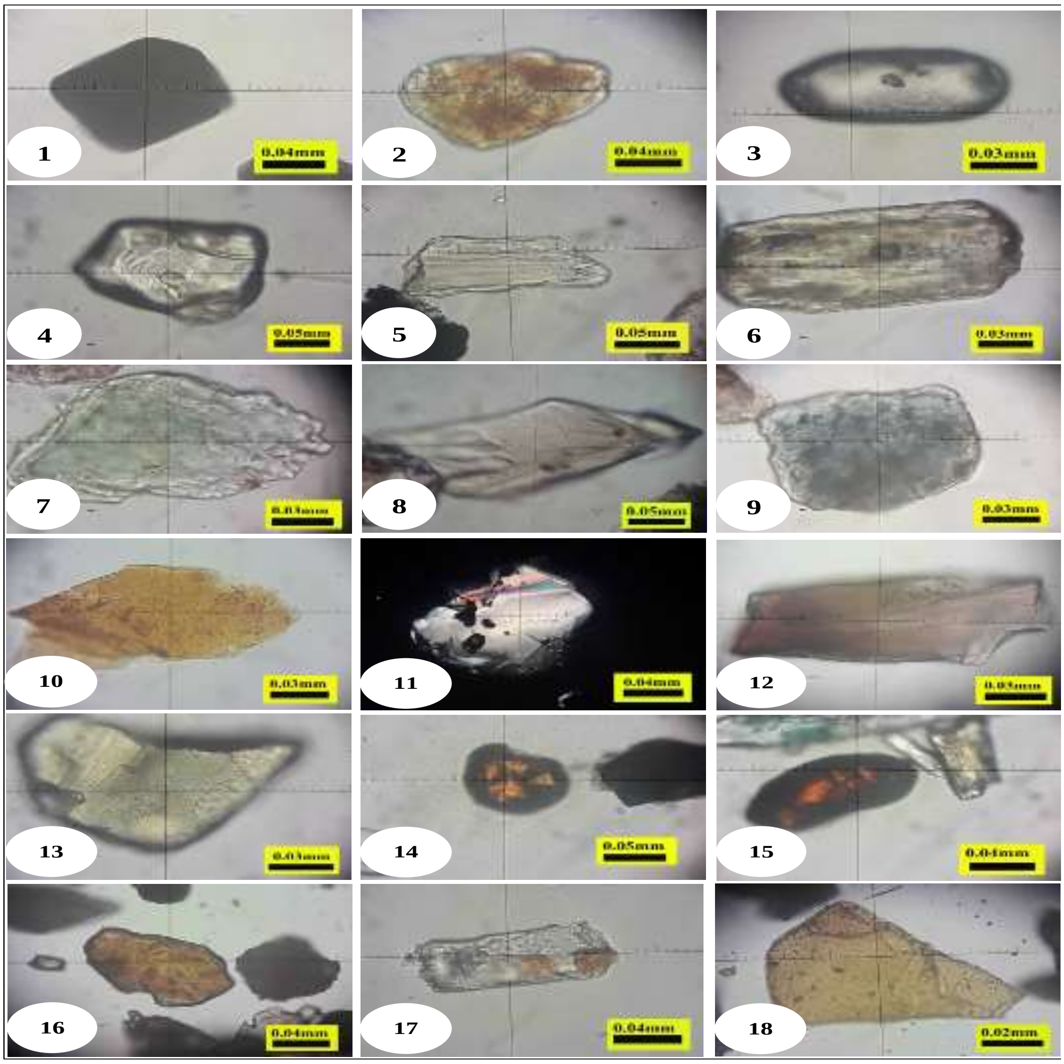

Figure 7: Bar chart represent the percentage of heavy minerals in the studied samples.

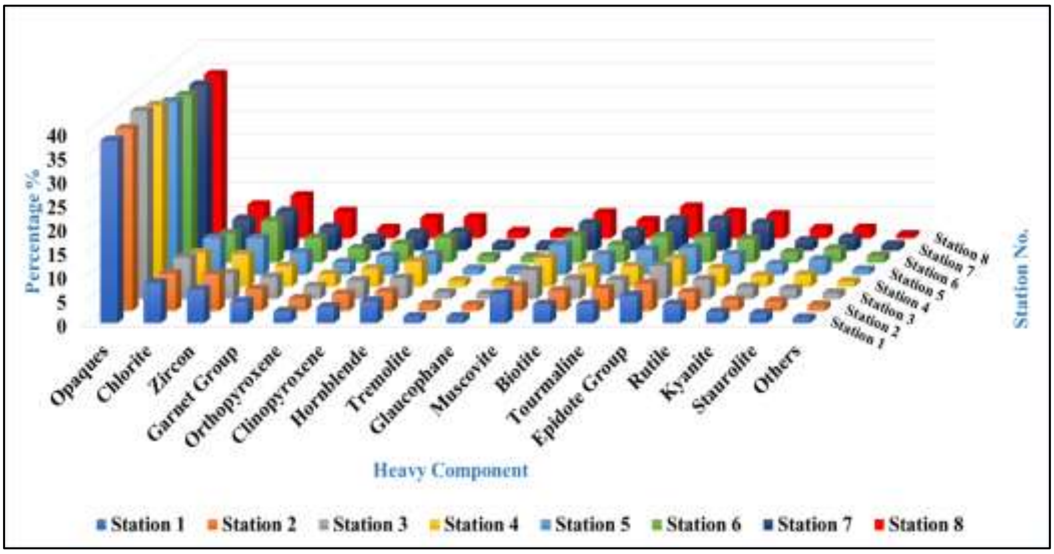

Figure 8: Images of heavy minerals in the studied samples of the studied area; 1: Opaques, 2: Chlorite, 3: zircon, 4: grossularite garnet, 5: orthopyroxene, 6: clinopyroxene, 7: hornblende, 8: actinolite, 9: glaucophane., 10: biotite, 11: muscovite, 12: tourmaline, 13: epidote, 14: rutile, 15: rutile, 16: staurolite, 17: kyanite, 18; staurolite.

Stability of Sediment

According to [11] and [12], the high percentage of opaque heavy minerals in clastic sediment refers to unstable clastic sediments, while the high percentage of ZTR (zircon tourmaline rutile) refers to ultra-stable clastic sediments. [13] created a ternary arrangement for determining the stability of heavy mineral concentration, in which unstable minerals, there are two types of groups: moderately-stable and ultra-stable are used. Submission of the stability issue to the areas during the study shows significant variances over several places, indicating different sources and types of source rocks (Figure 9).

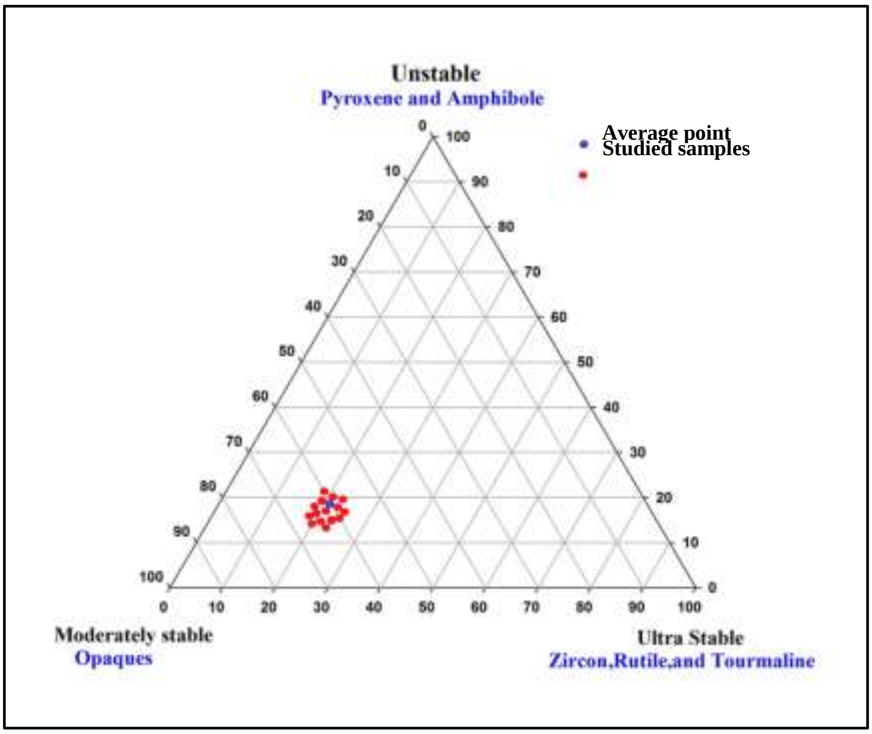

Figure 9: Ternary-diagram of heavy mineral stability of studied samples [12].

Source of Sediments

In certain depositional environments, such as these sediments, heavy minerals have been extensively carried out to regulate the transport and origin signatures, such as hills, coast, alluvial deposits, and rivers [13]. The provenance or source rocks are usually determined using heavy minerals [14]. The mineralogical character of the source terrains is constrained by heavy mineral data [15].

Heavy minerals are a varied and nongenetic mineral grouping found in detrital sediment and sedimentary rocks. The minerals are not essentially related to each other in any way. It is the effective technique in extrication that defines them as a group. Heavy minerals are parent rock minerals that have survived weathering [16].

The heavy mineral assemblages discovered in the samples under study point to several possible source rock types: Igneous, metamorphic, and sedimentary rocks are all included. It is possible that the widely studied heavy mineral assemblages are mostly made up of sedimentary rocks (outcrops of old sedimentary formation), acidic and basic igneous rocks, and low and high-rank metamorphic rocks.

Conclusions

The opaque heavy minerals are the most common component, followed by chlorites, amphiboles, zircon and tourmaline.

Different source rocks are indicated by the abundance of these heavy minerals, such as igneous, metamorphic, and sedimentary rocks.

The maturity and stability of these sediments 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 areas of study in the river terraces and flood plain of the river in the Mesopotamian Plain. Another source of these sediments is the aeolian deposits that separated from sand dune fields in the studied area and outcrops of sedimentary formation in southeastern Iraq as specified by the incidence of the carbonate rock fragments.

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