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MINERALOGY OF RECENT SEDIMENTS OF AL-TEEB RIVER BASIN-EAST MISSAN GOVERNORATE, SOUTHEASTERN IRAQ

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ABSTRACT

This research aims to define the mineralogical composition of recent sediments that were deposited around the Al-Teeb River basin in the east Missan Governorate and try 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. 15 samples were collected from eight stations of recent sediment that was deposited around the Al-Teeb River; two field works are covered (December 2019 and August 2021). Mineralogical study of the sediment after separating the light and heavy minerals by heavy liquid Bromoform in order to determine the mineralogical composition of the studied samples by using the petrographic microscope the light mineral fraction composed (95.5%) of the total mineralogy. The light components of these sediments consist mainly of quartz about 25.31%, feldspars (potash and plagioclase feldspar) about 9.53%, sedimentary rock fragments (carbonate rock fragments up to 33.39%, chert rock fragments 7.65%, evaporates fragments, 7.31%), (igneous rock fragments, and metamorphic rock fragments about 6.94%). The major component of the heavy minerals residue is opaque minerals with a range of 36.76% and non-opaque minerals with a range of 63.24%. The non-opaque minerals are mainly 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 sediments have two types of stability: moderately stable and ultra-stable. The mineralogical composition shows that the major sources of these sediments are; 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 ancient sedimentary formations in the southeastern of Iraq as specified by the incidence of the carbonate rock fragments.

INTRODUCTION

The study area is considered an important task at the present time to determine the provenance and kinds of the sediments and minerals to recent sediments for the Al-Teeb River basin, it is part of the Mesopotamian Plain, and the Al-Teeb area covers 1191 Km^2. Al-Teeb River is a seasonal river with a maximum length of about 60 Km that passes through the study area flows from Iranian territory and ends in Hor Al-Snnaf outside the boundaries of the study area.

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Al-Teeb River basin is located east of Missan Governorate southeastern Iraq, the sedimentary Formations that are outcrop in the northeast part of the study area are Bai-Hassan and Mukdadiya Formations, which represent Tertiary deposits, while Quaternary deposits cover the rest of the area (Barwary, 1993).

Tectonically Al-Teeb River basin is located within the unstable shelf (Buday and Jassim, 1987). Which represents the main portion of the Mesopotamian Plain and is characterized by shallow subsurface longitudinal anticlines separated by syncline with the direction of the northwest-southeast with a number of faults associated with these folds exist within the area between Al-Teeb and Sheikh Faris (Al-Kadhimi *et al*., 1996).

The research aims to determine the main types of sediments in the studied area and to determine the mineralogy of these sediments.

SITE OF STUDIED AREA

The study area is set northeast of Missan Governorate, southeast 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 Km^2. The topography varieties between (14 – 200 m) above sea level (Al-Ali *et al*., 2017). The land surface in the central part of the study area is relatively flat and it is limited by Himrin hills in the northeast. Al-Teeb River runs through the study area that comes from Iranian land (Figure 1).

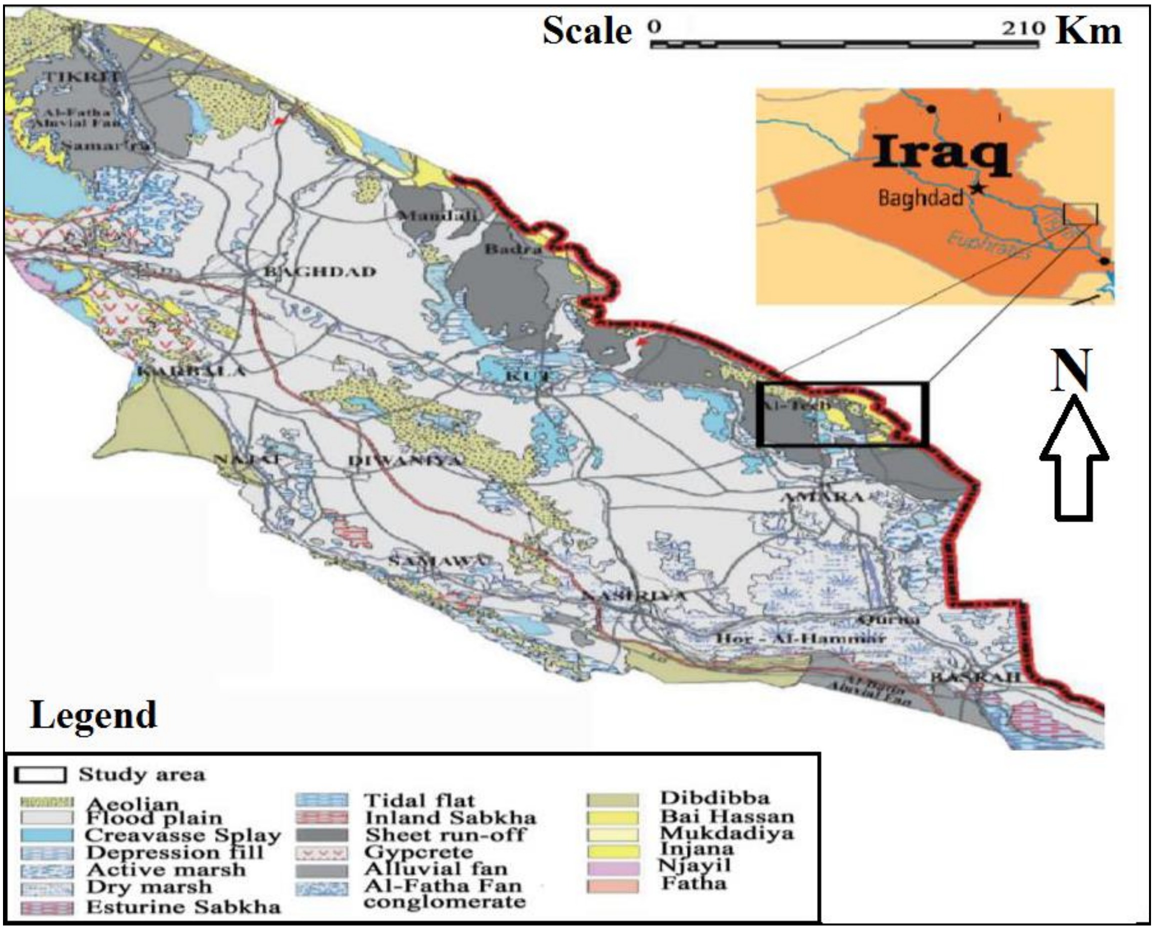

Figure 1: Location map of study area (GEOSURV, 1993).

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% of the study area, while Tertiary sediments extend over 28% of the study area. Undifferentiated Mukdadiya (late Miocene – Pliocene) and Bi Hassan (upper Miocene – Pliocene) Formations represent the stratigraphic column in the study area. 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 (Buday, 1980). Bai Hassan Formation is composed of interbedding of conglomerate, mudstone and sandstones (Barwary, 1993). In addition, several major normal and thrust faults are identified in the study area (Sissakian and Fouad, 2016; Figure 2).

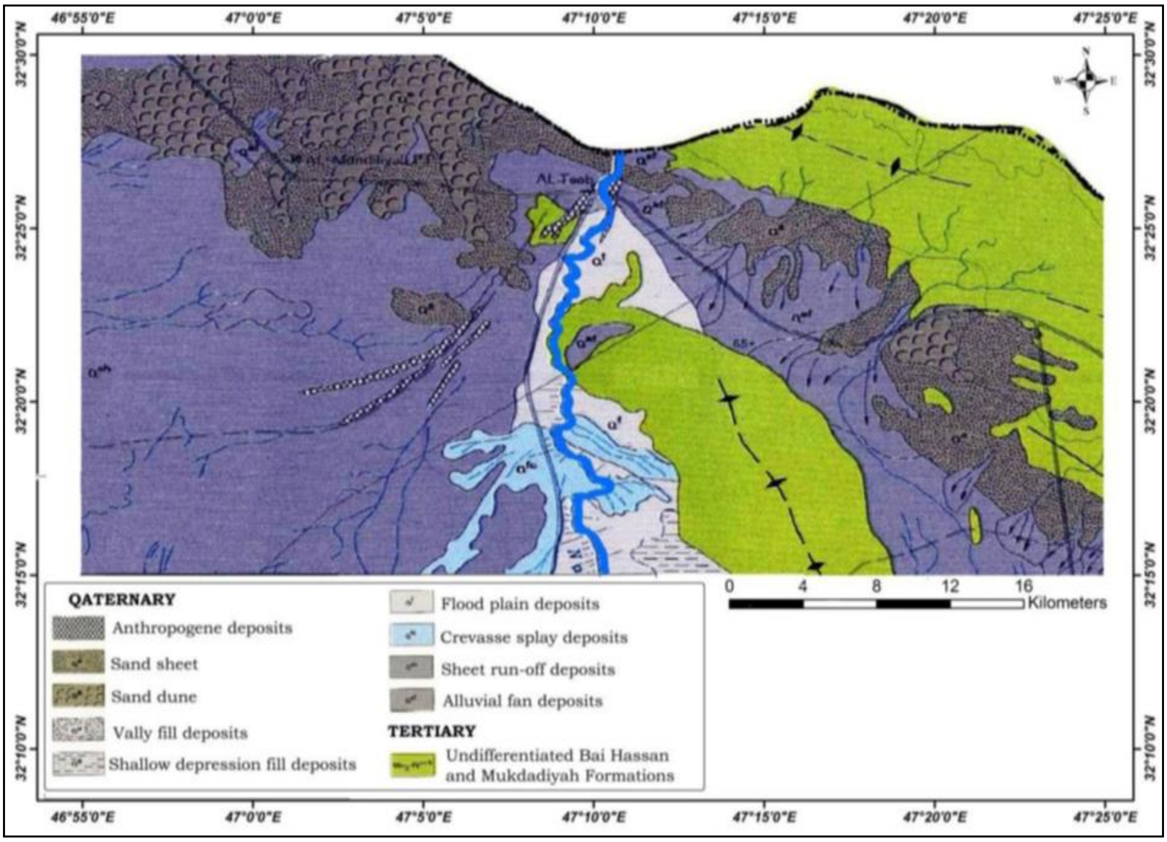

Figure 2: Geological map of the studied area (Barwary, 1993).

METHODS OF STUDY

15 samples were collected from eight stations of recent sediment deposited around Al-Teeb River, and two field-works were covered (December 2019 and August 2021), using the normal bromoform methods, the fine and very fine size fractions were sorted into heavy and light mineral fractions. The mineralogical configuration of both the heavy and light fractions was studied by using a polarizing microscope and the usual counting technique.

RESULT AND DISCUSSION

▪ Light Components

Samples of sediments' light mineral fraction composed of 95.5% of the total mineralogy. The percentages of light components in the studied samples are summarized in Table 1 and Figure 3.

Table 1: Percentages of light minerals of the 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

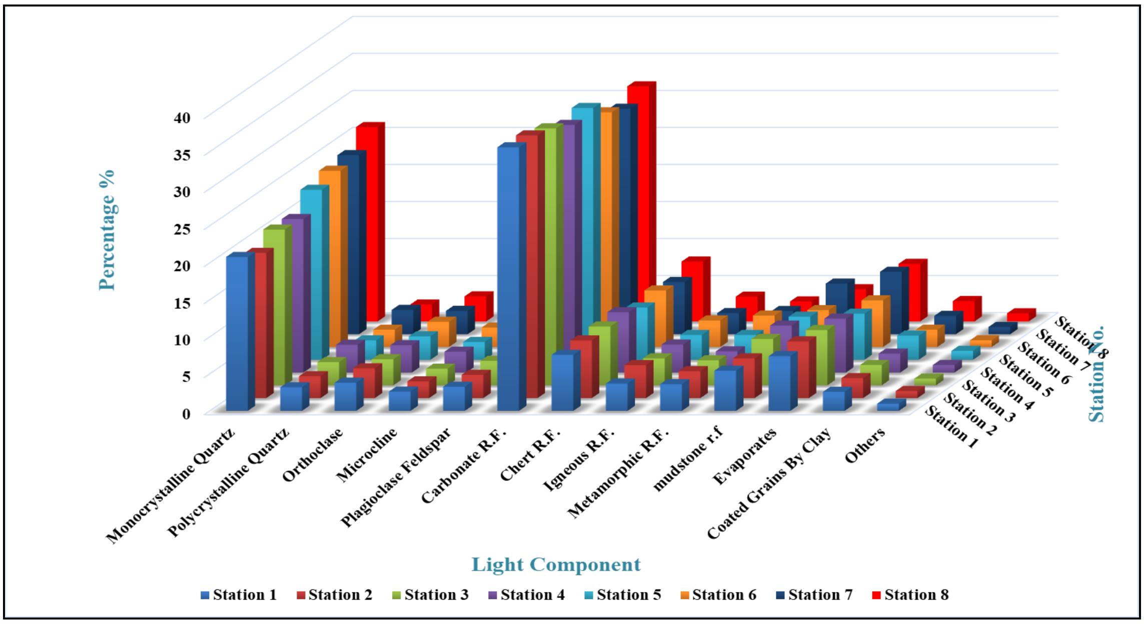

Figure 3: Bar chart represents the Percentages of light components in the studied samples.

Most quartz grains are monocrystalline, without an 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 up 33.39%, and are found mostly of calcite and dolomite happening as older formation rock fragments with distinct micritic and recrystallized components clear crystals and biogenic shell fragments are also present, and to a lesser extent. Evaporites Percentage are 6.15% of the light segment, they are mostly comprised of gypsum and anhydrite. The percentages of igneous and metamorphic rock fragments are 5.43%. The studied samples contain about 5.19% mudstone rock fragments, and coated grains by clay make up 2.7% of studied samples the identification of these grains is difficult due to the coated grains by clay. These components are shown in (Figure 4).

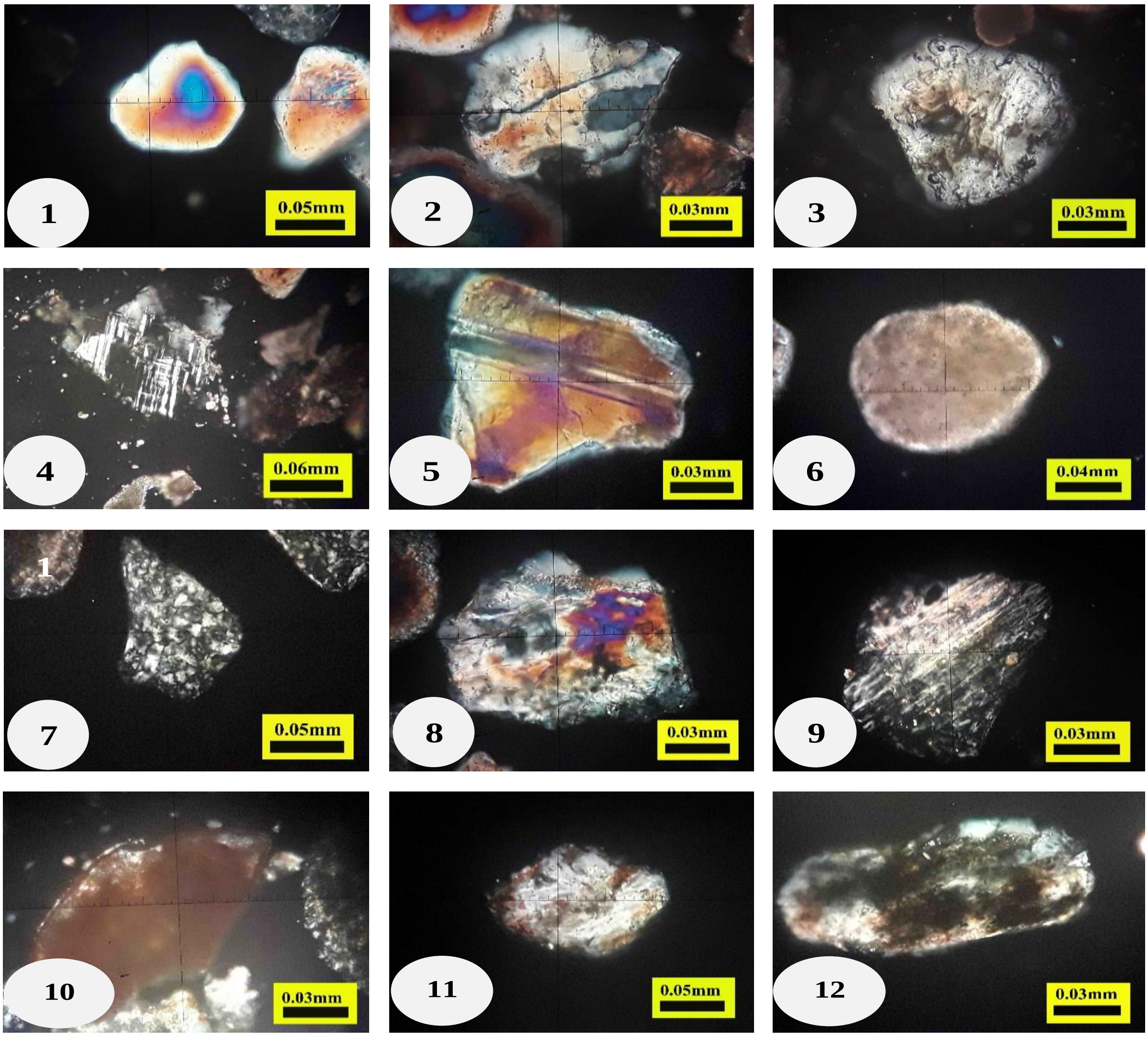

Figure 4: Images of the light minerals in the studied samples, whereby **1)** rounded monocrystalline quartz, **2)** sub-rounded polycrystalline quartz, **3)** orthoclase potash feldspar, **4)** microcline potash feldspar, **5)** plagioclase feldspar, **6)** carbonate rock fragment, **7)** angular chert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

- **Heavy Minerals**

The heavy minerals found in 15 samples from eight stations of recent sediments of Al-Teeb River Basin were resolute in order to apply them to determine the types of source rock the nature of the source area and the stability of the mineralogical composition of these sediments. The heavy mineral analysis separation process was followed after (Tucker, 1988), (Müller, 1967), (Griffiths, 1967) and (Carver, 1971). The amount of heavy minerals found in the samples was calculated using a point counter mechanical stage and the method of (Fleet, 1926).

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 from both orthopyroxene and clinopyroxene 6.37%, amphiboles composed from 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 and Figure 5. The shape of these minerals varies from rounded to angular, while the habit varies from prismatic to flaky (Figure 6).

Table 2: The 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

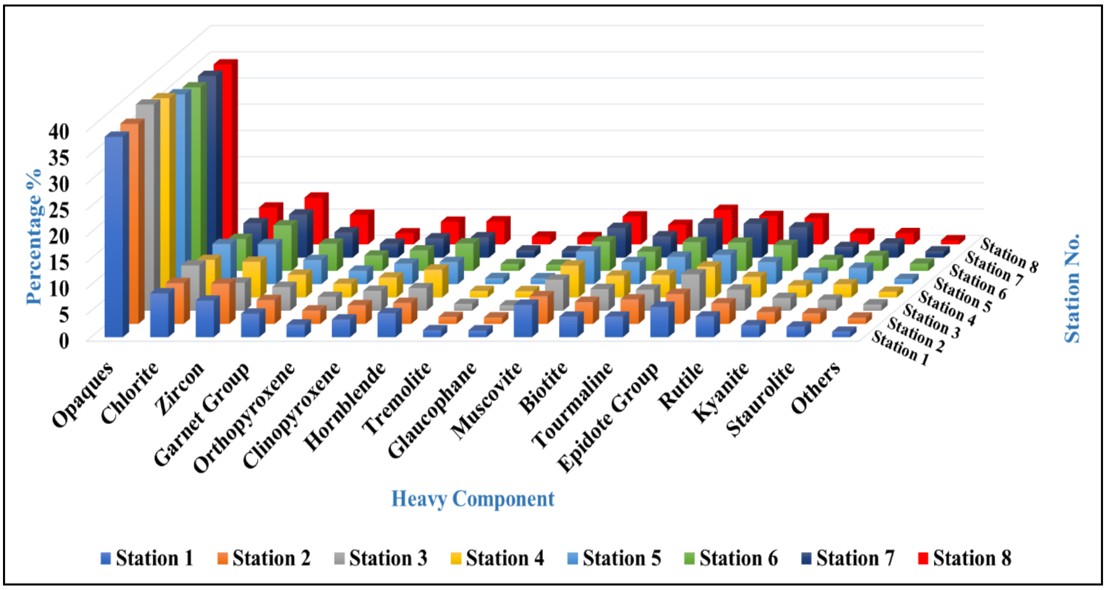

Figure 5: Bar chart represents the percentages of heavy minerals in the studied samples.

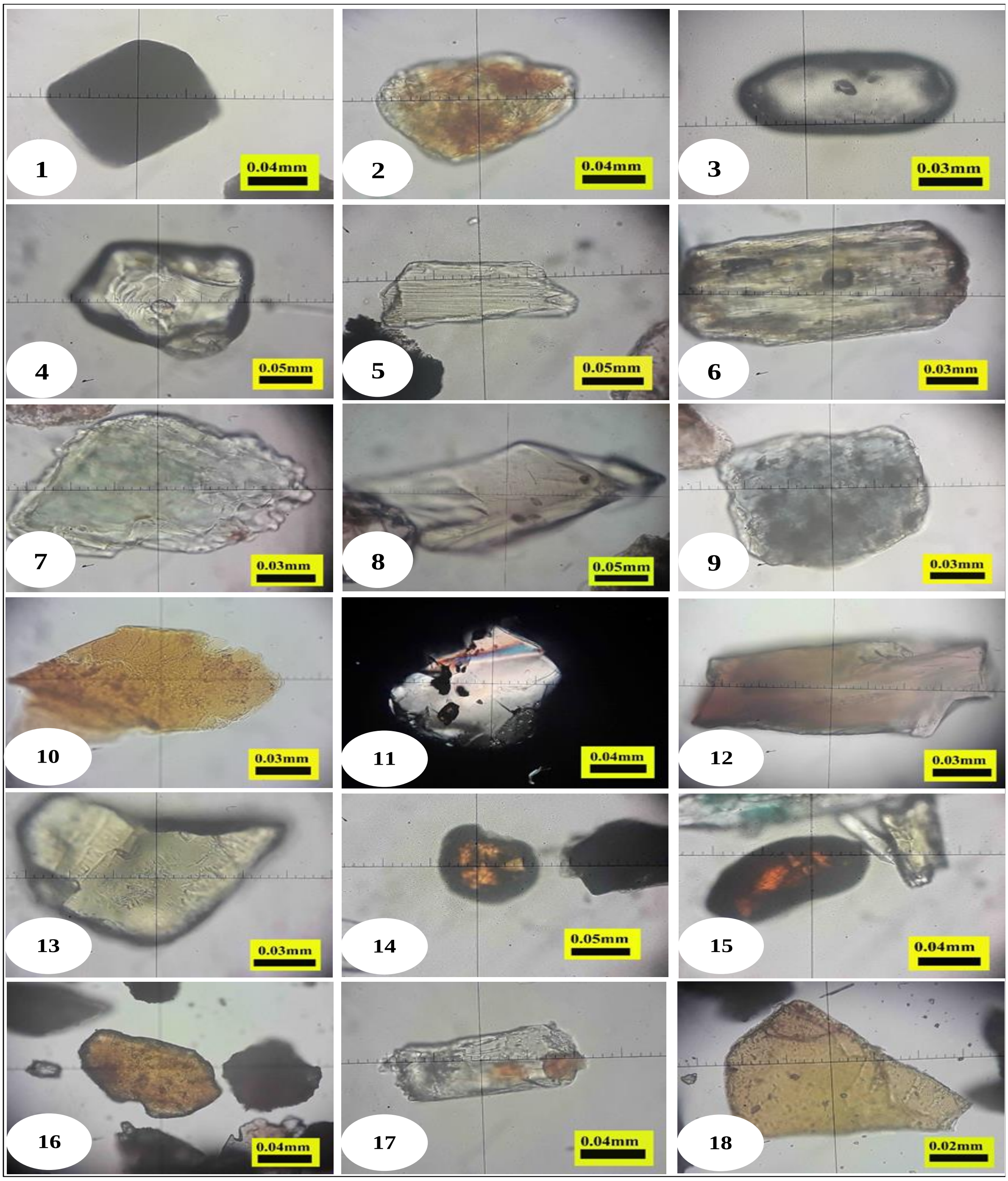

Figure 6: Images of heavy minerals in the studied samples of the studied area, where **1)** Opaques, **2)** Chlorite, **3)** zircon, **4)** Grossularite garnet, **5)** orthopyroxene, **6)** clinopyroxene, **7)** hornblende, **8)** Actinolite, **9)** Glaucophane, **10)** biotite, **11)** muscovite, **12)** tourmaline, **13)** epidote, **14)** Rounded rutile, **15)** Subrounded rutile, **16)** staurolite, **17)** kyanite, **18)** staurolite.

STABILITY OF SEDIMENT

According to (Folk, 1974) and (Nesse, 2000), the high percentage of opaque heavy minerals in clastic sediment refers to un-stable clastic sediments, while the high percentage of ZTR (zircon tourmaline rutile) refers to ultra-stable clastic sediments. (Kasper *et al*., 2008) 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 that there are significant variances over several places, indicating dissimilar sources and types of source rocks (Figure 7).

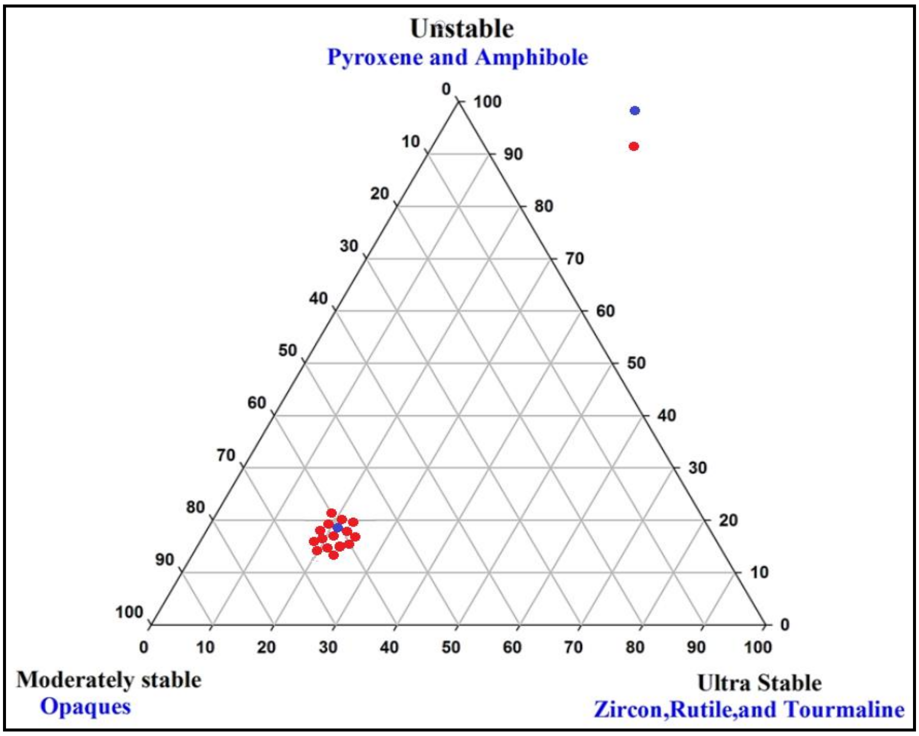

Figure 7: Ternary-diagram of heavy mineral stability of studied samples (Kasper *et al*., 2008).

SOURCE OF SEDIMENTS

In certain depositional environments, such as these sediments, heavy minerals have been extensively carried out to regulate transport and origin signatures such as hills, coast, alluvial deposits, and rivers (Kasper *et al*., 2008). The provenance or source rocks are usually determined using heavy minerals (Boggs, 1995). The mineralogical character of the source terrains is constrained by heavy mineral data (Morton and Hallsworth, 1999).

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's the effective technique of extrication them that defines them as a group. Heavy minerals are parent rock minerals that have survived weathering (Jasim, 2009).

The heavy mineral assemblages discovered in the samples under study point to a number of possible source rock types: Igneous, metamorphic, and sedimentary rocks all are included. Taking into account each mineral's relative abundance and distribution, it’s possible that the widely studied heavy mineral assemblages, which are mostly made up of sedimentary rocks (outcrops of old sedimentary formation), acidic and basic igneous rocks, low and high rank metamorphic rocks.

CONCLUSION

In all sediment samples studied, opaque heavy minerals are the most common component, followed by chlorites, amphiboles, and total 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 major 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 the southeastern of Iraq as specified by the incidence of the carbonate rock fragments.

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