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Effect of the Source of Sedimentation in the Mineralogical Composition of the Sand Fraction to Some Areas of the Southern Part of the Iraqi Alluvial Plain

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Abstract:
This study was conducted to know the effect of the source of sedimentation in the mineralogical composition of sand fraction for some areas of the southern part of the Iraqi alluvial plain. The results of mineralogical composition of sand fraction showed that the dominant minerals, in the light part of sand fraction, were carbonate rock fragments , qurtz , chert , mudstone rock , feldspars , igeous and metamorphic rocks . While , the heavy part showed a similarities in terms of quality and differences in terms of quantity , with dominance of Opaque minerals followed by Staurolite , Kyanite , Rutile , and Tourmaline . In general, the results showed the low rates of the heavy metal group compared to the light metals group of the sand fraction resulting from weathering occurring in their moving places during transportation or after the deposition, this may be attributed to the nature of the mineralogical composition of the deposits material source.
Keywords: sediments , minerals , sand fraction , Microscopic characteristics , optical of minerals , petrographic microscope , petrography
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1 - Introduction

The primary minerals referred to the minerals were formed at the high temperatures and associated with igneous and metamorphic rocks that break down under the influence of physical weathering without significant change in their chemical composition. The most common minerals in this group were quartz SiO_2, feldspar $MAlS_3O_8$ (M representing the totals of sodium, potassium, and calcium cations), while other groups of primary metals such as amphibole, pyroxene, mica, and olivine, were less quantity than quartz or feldspar. The primary metals were different in terms of chemical composition and crystal structure, thus they differed in the extent of their resistance to heat. All sand and silt grains that diameters ranging between (2-0.002) µm can be classified as primary metals (Al-Rawii *et al.,* 1986).

zaker *et. al.*, (2013) found that the sand was found naturally as metallic grains that consisted from rocks, and sand composition was variable depending on the rocks that consisted from. The most common sand was the silica (SiO_2), which always takes the quartz form. The sand might have different sizes such as Glacial moraines, vivers, and gravel. Nadewii (1983) noted that most of the prevailing minerals, in the sand fraction of alluvial plain of Iraq, was Opaque minerals, altranite, Epidote, amphibole, and pyroxene with a small proportion of the granite, zircon, quartz, muscovite, calcite, Albite, and orthoclase metals. Color is one of the most important features of the primary metals (primary silicate); the quartz and aluminum silicate had a light color forming the most of sand light metals, while manganese iron metals, forming most of the heavy sand metals, were dark if not black since the black color resulted from the presence of ferrous (Fe^{+2}) (Battikhi and Khatari, 1999).

Dill (1998) and Folk (1974) indicated that the study of heavy metals is one of the more important studies due to determining the quality of rock source, conditions of weathering, and subsequent processes that sediments exposed until precipitation. There are several factors controling the determination of quantity and quality of the heavy metals including the nature of the source rocks, physical sorting, mechanical abrasion, chemical weathering factors, and solvent. Physical sorting occurred as a result of hydrodynamic conditions during transport and deposition stages; this factor controlled the abundance of heavy metals in the sediments. The mechanical abrasion occurred during transport process reducing the particle size by fracture and roundness, while dissolving caused partially or entirely loosing of some types of heavy metals, particularly unstable heavy metals that showed low stability because of the influence of different chemical weathering during sedimentary cycles (Hou and Frakes, 2004).

Abbas (1989) stated that silicates minerals were complex composition, and they consist basically from Si-O tetrahedron, their composition of central silicon ion was surrounded by four ions of oxygen stacked as equal dimensions. It had a pyramid shape, and its base formed from three ions of oxygen while the peak had one oxygen ion. The positive charges of silicon Si^{+4} were neutralized to negative charges of the oxygen ions O^{-2} i.e. one charge of each ion keeping each oxygen ion had a negative charge, while the Tetrahedron had four negative charges, $SiO4^{-4}$. Tetrahedrons connected with each other by different methods, and the type of connection determined the structure of the crystal, as well as its resistance to weathering; there are differences in the structure of the Tetrahedron due to the replacement of Al ion instead of Si ion in the crystal structure named

"Isomorphous replacement" which, in this condition, is a neutralization of negative charges with Na, K, Ca, and Mg cations.

2- Materials and Methods:

2 – 1 - Pre-trial proceedings:

The study area were selected in the lands within Wasit and Maysan provinces at latitudes (33. 06¯) and (32˚. 08¯) north, and longitudes (44˚. 40¯) and (46˚. 56¯) to the east. This area was the part of the southern Alluvial Plain of Iraq which run through Tigris River, which forks to Gharraf River after passing Kut dam in the south and empties into the Tigris River, south of Kut dam, approximately 45 km Aljbab River, which flows from Iranian lands, its water source is the rainfall and has high salinity water.

2 – 2 - Field procedures:

The study area was divided into two zones:
Zone one (Z1): Located in the north of Kut dam.
Zone Two (Z2): Located in the south of Kut dam.
Two transects, intersect Tigris River from the west to the east, were selected. The first transect located within Z1 of the study area which included four sites soil pedons represented by the following sites (with pedons numbers):
- *gballa (pedon No. 11)*: Located on the right of the Tigris River, approximately 20 km away from the river.
- *Essaouira$_1$ (pedon No. 10)*: Located on the right of Tigris River, about 1 Km away from the river.
- *Essaouira$_2$ (pedon No. 9):* Located on the left of Tigris River, about 1 Km away from the river.
- *Tajuddin (pedon No. 8)*: Located on the left of the Tigris River, about 20 Km away from the river.

While the second transect located within Z2 of the study area which included four sites soil pedons represented by the following sites (with pedons numbers):
- *Alhaii$_1$ (pedon No. 1)*: Located on the right of Gharraf River, about 1 Km away from the river.
- *Alhaii$_2$ (pedon No. 2)*: Located on the left Gharraf River, about 1 Km away from the river.
- *Ali algarbi$_1$ (pedon No. 3)*: Located on the right of Tigris river about 1 Km away from the river.
- *Ali algarbi$_2$ (pedon No. 4)*: Located on the left of Tigris river, about 1 Km away from the river.
- *Glatt (pedon No. 5)* : Located on the left of Tigris River, about 20 Km away from the river.

Two sites of soil pedons were selected within the area bounded by the left bank of the Tigris River and mountainous region at the Iran-Iraq borders, which considered as mixing zones affected by sediment from the mountainous border regions as well as the flood sediments of Tigris River:
Jassan (pedon No. 7) : Located within Z1.
Shihabi (pedon No. 6) : Located within the Z2.
Horizons morphology, according to soil survey and classification index (S.S.S.S. 1951), were described, and the first and second depths (from each pedon) of the ground water were selected.

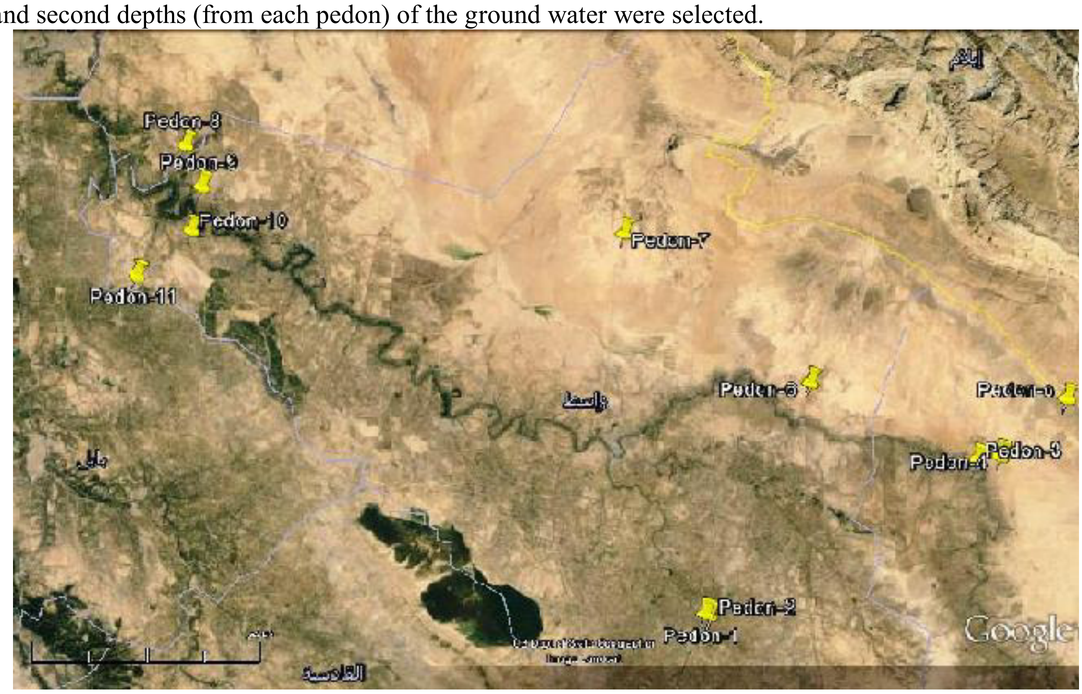

Figure 1: The distribution map of the study pedons in the Alluvial Plain of Iraq i Wasit and Maysan provences.

2 - 3 - Laborious procedures:

2 – 3 – 1 - Examination of sand by petrographic microscope:

Light metals were separated from heavy metals to an unbroken sand by means of bromoform (CHBr3) specific gravity (2.89) according to milner (1962) and strewn particles sand (light and heavy metals) after drying aerobically on a glass slide (slide has the same dimensions (25 * 75 mm)) and proven by a substance (canda balsam) break it coefficient (1.54), then the glass slides examined microscopically based on the method of Brewer(1976) and diagnosed minerals in the light of the metal optical qualities and according to Kerr's (1977) and Nesse (2000) at the Faculty of Science - Department of earth and filmed models using the microscope type (Lietz) German-made and a camera of the same type, and calculated the percentage of each metal to conduct counting the bullet to a count bulleted process by (point counter) for 300-250 grain of sand / slice, and calculate the percentages of each metal on the manner outlined in black.1965.

3 - Results and Discussion :

3 – 1 - Diagnosis of Sand Metals

3 – 1 – 1 - Light Metal:

The polarized microscope was used to diagnose sand metals after separating light and heavy metal on each other of the study pedons. Light metal group included quartz (both of mono crystalline and poly crystalline) and feldspar (both of alkali and plagioclase); and rock fragments included carbonate, chert, Igeous, metamorphic, and mudstone.

- Quartz Group:

quartz is on of very weathering-resistant, solid, and insoluble minerals (Jovial *et al.,* 2000). Tables (1,2,3 and 4) showed the percentages of quartz mineral that ranged between (1.1 – 6.21 %) with rate of (11.35%). Both types of quartz, mono and poly crystalline, were diagnosed in all of the soil pedons. The mono crystalline quartz was diagnosed on the basis of straight non to slightly undulos extension (Tucker, 1985).It appeared as a single crystal (plate . 2) and ranged between (4.7 – 6.21 %) with rate of (14.5%). The highest value appeared in the first depth of pedon No. (1), and the lowest value was in the first depth of pedon No. (3), within Z_2. The particles were characterized as coarse – fine and angular. The granular form indicated that the metal particles were not exposed to the polishing and roundness due to the transfer from the source because of the light weight where it was carried by water to long distances.

For poly crystalline (plate 2), the percentages ranged between (1.1 – 7.3 %) with rate of (2.4%). the highest value appeared in the second depth of the pedon No. (4) within Z_2, and the lowest value was in the second depth of pedon No. (8), within Z_1. The particles appear as composite quartz which consist from two or more crystalline modules with different visual guidance (Tucker, 1985). Particles were medium in size with undulos extension, and angular to semicircular shape (Blatt, 1967, Folk, 1975, Basu et al., 1975).

Light Components	Light Components					
	Samples Number					
	P1 d1	P1 d2	P2 d1	P2 d2	P3 d1	P3 d2
Monocrystalline Quartz	18.3	12.7	16.8	15.2	7.4	12.5
Polycrystalline Quartz	2.3	2.2	2.6	3.5	1.2	4.2
Alkali Feldspar	3.2	3.4	3.5	3.6	1.4	3.2
Plagioclase Feldspar	1.8	2.3	2.8	2.5	0.8	1.8
Carbonate Rock Fragments	38.1	39.6	42.7	39.2	30.9	38.5
Chert Rock Fragments	12.3	10.6	10.8	8.5	6.6	9.5
Igneous Rock Fragments	2.8	2.9	2.8	2.6	1.8	2.2
Metamorphic Rock Fragments	1.7	3.3	1.5	2.8	1.6	3.5
Mudstone Rock Fragments	4.2	7.3	3.6	7.5	8.6	8.6
Evaporates (Gypsum + Anhydrite)	11.3	9.6	7.6	9.6	33.6	10.2
Coated Grain by Clay	2.1	2.8	2.7	3.5	2.6	3.1
Others	2.0	2.3	2.6	1.5	3.5	2.7
Heavy Minerals	**Heavy Minerals**					
	P1 d1	P1 d2	P2 d1	P2 d2	P3 d1	P3 d2
Opaques	29.7	42.1	36.4	40.0	35.9	39.7
Chlorite Group	13.5	7.3	10.5	9.6	9.5	9.5
Zircon	7.3	8.2	7.6	6.9	7.2	6.6
Garnet Group	5.2	5.3	4.8	4.5	5.1	4.8
Pyroxene Group	6.5	6.5	5.8	5.9	6.2	5.9
Amphibole Group	7.7	5.8	6.7	6.3	6.7	7.0
Tourmaline	1.5	1.5	1.5	1.7	2.3	-
Epidote Group	5.3	5.3	5.7	6.1	6.1	6.8
Rutile	2.2	2.6	2.5	2.1	2.8	2.6
Kyanite	2.4	1.5	2.7	2.1	2.7	2.0
Staurolite	3.2	3.1	3.3	3.1	2.7	2.2
Biotite	4.8	2.8	3.5	3.8	5.2	4.1
Muscovite	7.8	5.9	6.2	5.8	5.1	6.1
Others	2.9	2.1	2.8	2.1	2.5	2.7

Table 1: Percentages of light and heavy metals of soil pedons (1, 2, and 3).

The high quartz ratios of the soil pedons were attributed to the effect of the nature of the original material of studied soils that were originally enriched with the quartz, which was the main component of sand particles and high resistance to weathering (Adhami, 2006). Tucker (1998) attributed the increment in the percentages of quartz mineral to several reasons: 1) its resistance to weathering due to the nature of chemical bounds, 2) its hardness and cracks free, and 3) Due to its light weight, quartz particles were carried by water to far distances and deposited at low momentum transfer powers. Therefore, it was the most stable mineral under the depositional conditions. Quraishi (2012) explained that all processes of carving, transport, and collision of particles in each other were factors led to minimizing smooth particles so the quartz mineral was dominant in the horizons of study soils. In general, the results show that quartz metals distribution ratios were very approached with random distribution for all study soils indicating that both deposits, whether those transmitted by Tigris River or those coming from the borderline, contribute to the transfer and deposition of quartz metals.

- Feldspars:

This group consists of aluminum silicates with one or more of sodium, potassium and calcium oxides. Feldspar was diagnosed with both types (alkali and plagioclase). Tables (1,2,3 and 4) showed the percentage of feldspar which ranged between (0.8 – 3.6 %) with the rate of (2.2%). The highest value was in the second depth of the pedon (3) and the lowest value was in the first depth for the same pedon (3).

Alkali feldspar (orthoclase) was diagnosed within the pedons soil in the current study (plate 1), and its percentage ranged between (4.1 – 6.3 %) with rate of (2.5%) (Tables: 1,2,3 and 4). The highest value was in the second depth of the pedon No. (4), and the lowest was in the first depth for the pedon No. (3). Through microscopic examinations, we found that the metal characterized as clear foggy, abraded edges, and subhedral with a simple twinning and changing some parts to sericite and kaolinite (Pichler *et. al.,* 1997). Khafaji *et. al.,* (2010) found that Orthoclase is one of the minerals that crystallize within the monoclinic system , prismatic crystal, had a twinning, the color ranging as a pink and might be white , red, gray, or colorless sometimes, rarely being yellow or green, had a glass brilliance, half semitransparent, and specific gravity 2.57. The microscopic examinations showed the existence of black spots on the metal surface, and this was probably due to the alteration of the metal towards the other metals which named "dotted alteration" by Bullock *et. al.,* (1985) which starts as isolated dots that transformed into more stable metals by weathering processes.

Regarding to the plagioclase, metal optical characteristics showed that albite was the dominant metal within this group (plate 2) .The metal appeared angular - sub angular characterizing by multiple twinning which distinguishing it from alkaline feldspar (Pichler *et al.,* 1997). Tests showed that albite had a clear two directions cracking, one complete and the other less obvious, indicating that the metal exposed to a transformation named "irregular liner" by Bullock *et. al.*, (1985).

Light Components	Light Components					
	Samples Number					
	P4 d1	P4 d2	P5 d1	P5 d2	P6 d1	P6 d2
Monocrystalline Quartz	15.7	14.9	16.3	21.0	13.6	12.5
Polycrystalline Quartz	2.7	3.7	2.5	3.2	2.1	2.3
Alkali Feldspar	3.5	3.6	2.8	2.8	2.6	2.1
Plagioclase Feldspar	1.8	2.6	1.8	2.3	1.2	1.6
Carbonate Rock Fragments	42.2	43.6	42.8	42.1	43.6	40.2
Chert Rock Fragments	10.5	9.6	11.6	10.5	8.6	8.2
Igneous Rock Fragments	2.6	2.8	1.7	2.1	2.1	1.8
Metamorphic Rock Fragments	1.8	2.5	1.8	1.5	1.8	2.1
Mudstone Rock Fragments	6.0	4.9	5.8	4.6	7.6	6.7
Evaporates (Gypsum + Anhydrite)	8.3	7.5	7.5	6.3	13.6	17.6
Coated Grain by Clay	2.8	2.5	2.8	2.1	2.1	3.1
Others	2.1	1.8	2.5	1.5	1.1	2.1
Heavy Minerals	**Heavy Minerals**					
	P4 d1	P4 2d	P5 d1	P5 d2	P6 d1	P6 d2
Opaques	38.6	32.9	38.9	34.8	42.7	43.3
Chlorite Group	11.5	12.8	9.8	8.5	9.5	8.6
Zircon	7.9	7.5	6.9	7.9	6.8	8.5
Garnet Group	4.9	5.5	5.9	6.5	5.7	4.9
Pyroxene Group	5.9	6.2	5.8	6.3	5.6	6.1
Amphibole Group	6.2	7.4	6.7	7.2	6.2	4.8
Tourmaline	1.2	1.6	1.3	2.2	1.2	1.6
Epidote Group	5.3	5.4	5.3	6.4	5.6	4.7
Rutile	1.8	2.3	2.4	2.1	2.3	2.1
Kyanite	2.4	2.5	1.6	2.2	1.9	1.7
Staurolite	2.7	3.6	3.6	2.8	2.3	2.5
Mica: Biotite	4.3	3.7	3.5	4.1	3.8	3.9
Mica: Muscovite	5.8	6.5	5.8	5.6	4.9	5.2
Others	1.5	2.2	2.5	3.5	2.5	2.1

Table 2: Percentages of light and heavy metals of soil pedons (4,5,6)

The results (Tables: 1,2,3 and 4) showed that the percentage of the plagioclase group ranged between (0.8 – 2.8 %) with rate of (1.8%); the highest value was in the Ap horizon at the first depth of the pedon No. (2), and the lowest value was in the Ap horizon at the first depth of the pedon No. (3). Those ratios were very approached with random distribution for all study soils and there was no differentiation in the quantity of feldspar metals that transferred and deposited in these soils. albite was found in white color and had a glint characteristic that called a moonstone (Bossily and Muthaffar, 1980).

- Carbonate Rock Fragments

This type of rocks is important because they indicated precisely depositional environment, thus they used to rebuild the geological history of their presence area .

These rocks are also important as sources of hydro carbonates and carbonate minerals in their later deposition areas, so the current study aimed to investigate, the effect of the deposits on the soil characteristics in the study area, in details.

The results (Tables: 1,2,3 and 4) showed the percentages of this group that ranged between (30.9 –

43.6 %) with rate of (37.25%). The highest value was in the first and second depth of the pedons No. (4 and 7) respectively, while the lowest value was in the first depth of the pedon No. (3).

In addition, metal optical characteristics (plate 1) showed the appearance of the crystals as arounded – subarounded shapes, and the size of their grains was very coarse to fine. This group represented the special conditions of the rapid mechanical erosion more than dissolving or chemical decomposition (Pettijohn *et al.,* 1987). The results (Tables: 1,2,3and 4) also showed that the rates of carbonate rock fragments were the highest on the left side of the Tigris River soils until the Iraqi-Iranian borders compared with the soils on the right side of the river. The increment in the rates of those rocks were toward the river, and their horizontal distribution along the lines of the current study was very corresponded with the horizontal distribution of calcium carbonate minerals in all study soils, especially within pedons soil of the left side of the river. This correspondence of the distribution can be interpreted to that those rocky fragments of carbonate were important source of carbonate metal in the soils whether the source was deposits carried by the river or those carried by floods descending from the highlands at the Iraqi-Iranian borders. Therefore, it can be concluded that the sediments transmitted by Tigris River and those transmitted by the floods of the border were important sources of calcium carbonate in the southern part of Alluvial Plain of Iraq. dissolving and re-deposition affect these rocks and forming new forms of carbonate later, in those soils (Al-Qaisi, 1991).

- Chert Rock Fragments:

Results (Tables: 1,2,3 and 4) showed that the percentages of this group ranged between (6.6 – 6.11%) with rate of (9.1%); the highest value was in the Ap horizon of the first depth in the pedon No. (5), and the lowest value was in the Ap horizon in the first depth in the pedon (3). (Plate 1) showed the metal optical characteristics which had grains with size ranged from very coarse to fine with an angular shape (Jassim , 2009). Those rocky fragments had no mentioned importance in the soil chemical characteristics.

Light Components	Light Components					
	Samples Number					
	P7 d1	P7 d2	P8 d1	P8 d2	P9 d1	P9 d2
Monocrystalline Quartz	11.6	10.2	9.6	8.3	12.4	10.7
Polycrystalline Quartz	1.8	2.1	1.4	1.1	2.9	2.5
Alkali Feldspar	2.9	3.1	1.8	2.1	3.2	2.8
Plagioclase Feldspar	1.7	2.4	1.5	1.6	1.8	2.6
Carbonate Rock Fragments	43.6	39.1	33.6	35.2	41.6	43.5
Chert Rock Fragments	7.6	7.6	7.2	7.8	9.5	7.5
Igneous Rock Fragments	1.5	1.4	1.3	1.1	3.2	1.6
Metamorphic Rock Fragments	1.8	1.7	1.2	0.8	2.6	1.2
Mudstone Rock Fragments	4.6	6.3	6.8	7.3	7.2	4.8
Evaporates (Gypsum + Anhydrite)	18.1	22.0	31.5	30.1	10.2	18.2
Coated Grain by Clay	2.5	2.1	1.9	2.5	2.6	2.8
Others	2.1	2.0	2.2	2.1	2.8	1.8
Heavy Minerals	**Heavy Minerals**					
	P7 d1	P7 d2	P8 d1	P8 d2	P9 d1	P9 d2
Opaques	45.7	43.6	36.9	34.5	38.2	37.5
Chlorite Group	11.1	9.5	8.9	9.6	10.6	9.6
Zircon	6.7	7.2	6.9	6.5	7.2	7.3
Garnet Group	4.2	3.8	5.2	5.6	6.8	5.4
Pyroxene Group	4.8	5.5	6.3	5.8	4.8	4.2
Amphibole Group	6.1	5.6	6.2	6.9	5.9	6.6
Tourmaline	-	0.7	2.5	2.8	1.5	1.4
Epidote Group	5.2	5.6	6.3	5.9	5.9	6.3
Rutile	2.3	2.5	3.1	1.8	2.3	2.3
Kyanite	1.8	2.8	2.2	2.9	1.8	2.4
Staurolite	2.6	2.3	2.9	3.4	2.9	2.8
Biotite	3.6	3.5	4.8	4.8	4.1	5.4
Muscovite	4.1	4.9	5.3	6.8	4.9	6.8
Others	2.0	2.5	2.5	2.7	2.5	2.0

Table 3: Percentages of light and heavy metals of soil pedons (7, 8, and 9)

- **Rock Fragments:**

This group consisted from many rock fragments:

1- Igneous Rock Fragments:

Igneous rocks formed from cooling and crystallization of magma and differ from each other depending on the places of cooling and chemical contents. It had two types of minerals: light color metals (quartz, feldspar, muscovite, and zeolite), and dark color (olivine, biotite, pyroxene, amphibole) (Hussein, 2003).

The results (Tables: 1,2,3 and 4) showed the percentages of those rocky fragments that ranged between (1.1 – 2.3 %) with rate of (2.15%). The highest value was in the first depth of the pedon No. (9), and the lowest value was in the second depth of the pedon No. (8). Mainly, their grains were volcanic rocky fragments, such as andesite, angular shape, and their grains size ranged between medium to fine.

2- Metamorphic Rock Fragment:

It is one of the rocks that have igneous or sedimentary origin that exposed to pressure and temperature factors led to change their physical and chemical characteristics. Their constituent metals were very coarse texture (Sunway *et al.,* 1979).

The results (Tables:1,2,3 and 4) showed the percentages of this group that ranged between (0.8 – 3.5 %) with rate of (2.15%). The highest value was in the second depth of the pedon No. (3), and the lowest value was in the second depth of the pedon (8) (Plate 1). This type is one of the Non-Foliated Rocks formed by the intense heat.

3- Mudstone Rock Fragments:

One of the most common sedimentary rocks that found in the form of interface layers within the other sedimentary layers. Siltstone , mudstone , mud shale , clay stone, and clay shale were the main types of mud rocks (Mameta, 2006).

The results (Tables: 1,2,3 and 4) showed the percentages of these rocky fragments, which ranged between (6.3 – 6.8 %) with rate of (6.1%). Results also showed that the highest value was in the first depth of the Pedon (1 and 2), and the lowest value was in the first and second depths of the Pedon (3) (Plate 2).

- Evaporates:

Evaporates contained all the mineral salts formed as a result of the evaporation of fluid enriched with salts and the deposition of salts from high concentration solutions. The evaporated rocks usually contain several metals, but the majority of these metals were rare and unknown such as of chlorides, sulphates, and borates. The most prevalent metals were carbonate (calcite, dolomite, magnetite), chlorides group (sulfide, halite, garnalite), and sulfate group (hydrate, polyhalite, garnet, lapegranat) (Mameta, 2006).

The results (Tables: 1,2,3 and 4) showed the percentage of this group which ranged between (5.3 – 33.6%) with rate of (19.45%). The highest value was in the first depth of the pedon (3) while the lowest value was in the first depth of the Pedon (1). The optical characteristics showed that the metal diagnosed within this group was gypsum (plate 1). Depending on the adopted optical qualities of Kerr (1959), the metal appeared colorless, white, or gray, and might appear yellow, red, or brown due to impurities, had glass to pearl brilliance, hardness 2, and the specific weight was 2.32. Bosaily and Muthaffar (1980) indicated that the gypsum metal was crystallized within the monoclinic system, and found within sedimentary rocks and often found under the rocky salt layers where sulfate value appeared in the (second depth) for the pedon (6), and the lowest value was in the (second depth) of the pedon (1). These low percentages of zircon metal are attributed to the nature and type of rocks originally composed for this constituent group to heavy metals in an particles sand which igneous rocks base and above the base, medium and rocks mutant followed by rocks wounds acidic (Milner, 1962). Microscopic examination (plate . 4) showed that the zircon is colorless, sometimes astray from the blue-violet or deep layers, with euhedral - subeuhedral forms ; prismatic and particles are the most common, and most scarce is sub angular. It has a diamond luster with a hardness of 7.5 and specific gravity 4.68 (Kerr, 1959). It is found within the metamorphic limestone rocks (schist and gneiss). The qualitative weight and chemical structure are among the factors to help the metal concentration in a small round pellets in the transported sediments (Bossily and Muthaffar, 2007).

Among the diagnosed minerals within the heavy metal group of soil pedons of the present study is Garnite, which is one of the metals resistance to weathering, with percentage of (8.4 - 8.6%) and the rate of (5.8%) , the highest value appeared in the (first depth) of the pedon (9) , and the lowest value was in the (first depth) of the pedon (7). Using the microscopic examination of the reflector (plate . 3), Garnite was characterized as colorless metal , and some full-faceted and has a

Light Components	Light Components					
	Samples Number					
	P10 d1	P10 d2	P11 d1	P11 d2		
Monocrystalline Quartz	13.6	12.6	21.6	17.3		
Polycrystalline Quartz	2.1	1.5	2.7	3.2		
Alkali Feldspar	3.0	3.3	3.6	3.1		
Plagioclase Feldspar	1.9	2.2	2.5	2.2		
Carbonate Rock Fragments	42.6	40.5	41.6	37.5		
Chert Rock Fragments	8.3	9.5	11.3	9.3		
Igneous Rock Fragments	1.6	1.3	1.5	3.8		
Metamorphic Rock Fragments	1.6	1.9	1.6	2.5		
Mudstone Rock Fragments	5.5	5.9	3.6	6.9		
Evaporates (Gypsum + Anhydrite)	14.4	15.6	5.3	8.3		
Coated Grain by Clay	3.0	3.4	2.5	2.8		
Others	2.4	2.3	2.2	3.1		
Heavy Minerals	Heavy Minerals					
	P10 d1	P10 d2	P11 d1	P11 d2		
Opaqes	32.6	36.9	35.7	43.3		
Chlorite Group	13.5	9.2	8.5	8.7		
Zircon	6.8	6.8	6.9	6.2		
Garnet Group	5.3	5.4	4.8	4.8		
Pyroxene Group	6.8	6.5	6.8	4.7		
Amphibole Group	6.9	7.3	6.5	5.2		
Tourmaline	1.6	2.6	1.6	1.1		
Epidote Group	5.6	5.9	4.8	5.6		
Rutile	2.3	2.9	2.6	2.8		
Kyanite	2.7	2.3	2.5	1.8		
Staurolite	2.8	3.2	3.3	2.6		
Biotite	4.2	3.3	4.7	4.7		
Muscovite	6.8	4.8	6.5	6.5		
Others	2.1	2.9	2.8	2.0		

Table 4 . Percentages of light and heavy metals of soil pedons (10 and 11)

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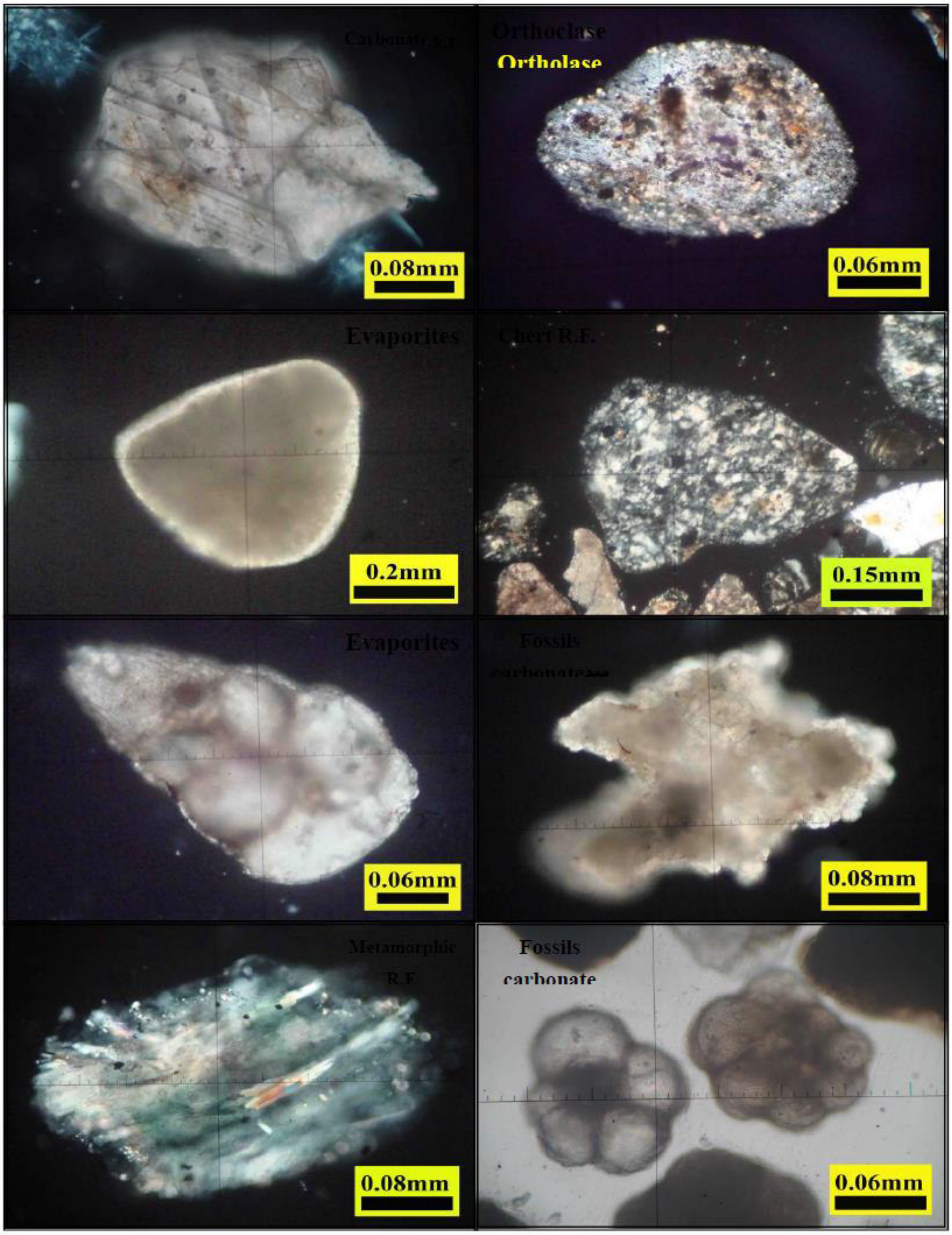

Plate 1 . Photos of some light minerals of soil pedons in polarized optical microscopy.

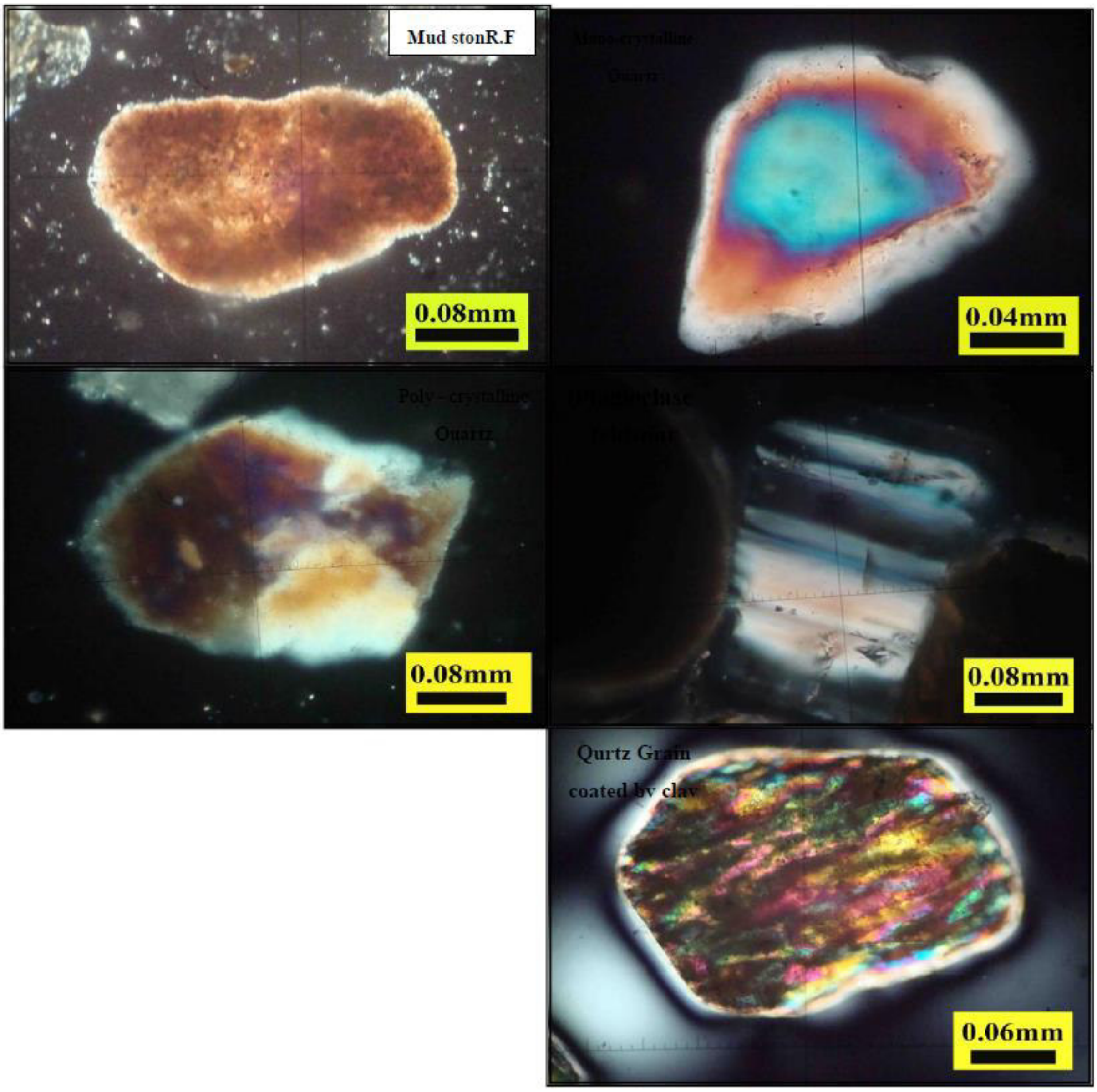

Plate 2 . Photos of some light minerals of soil pedons in polarized optical microscopy.

full Extinction with hardness of 7-6. The specific gravity is 5.3 to 3.3, has a virtues luster, and is one of the chemically stable metals (Jawad , 1977). It is derived from metamorphic rocks, especially the high-transition and igneous rocks above the basal (Harris, 1963).

The pyroxene metals group, which is one of the few resistance metals to weathering and represents one of the sources of magnesium ions in the soil, was salts deposited before chlorides during salty water evaporation process, or it might be formed as a result of anhydrite hydrolysis which could be distinguished from gypsum by relatively high hardness.

- Clay Coated grains:

The results (Tables: 1,2,3 and 4) showed that the percentages of this group ranged from (5.3 – 9.1%) with rate of (2.7%).The highest value was in the second depth of the pedon (2), while the lowest value was in the first depth of Pedon (8).

- Other minerals:

This group included some diagnosed metals (biotite, muscovite, and chlorite) which represented the weathered or diagentical metals (Jassim , 2009). The results showed the percentages of this group that ranged between (1.1 – 5.3%) with rate of (2.3%).The highest value was in the first depth of the pedon (3), and the lowest value was in the first depth of the Pedon (6). (Plate (3 and 4).

The results showed the prevalence of carbonate metal due to the nature of the original material enriched with carbonate minerals as most of the dominant original materials in Iraq were calcareous in, which played a big role in increasing carbonate content at the lower horizons (Husseini , 2010). There was a notable increase of quartz metal followed by evaporates metals , mudstone , chert , stone clay, igneous metamorphic, clay coated grains, other metals, and feldspar.

the sand were due to the nature of the laminate crystals, the specific gravity, the weak resistance to weathering, and transformation into secondary metals. The low rates of muscovite and biotite has attributed to the weakness of their resistance to weathering where they transformation into semictite under dry and semi-dry conditions (Mhamid and Saleh, 2007).

3 – 1 – 2 - Heavy Minerals:

They are from various minerals resulting from the breakdown of initial minerals by weathering, abrasion, or intrastate (solution). They had specific weight more than 2.85 (Pettijohn *et. al.,* 1987). The importance of these metals belongs to two reasons: 1) being the commercial value, and 2) being an indicator of source nature of rocks for those areas (Dill, 1998 ; Morton and Hallsoworth, 1999; Boggs, 2001).

Oqaili (2002) indicated that the most important heavy metals, diagnosed within the lands located east of Gharraf River south of Kut in the middle of the Alluvial Plain, were Opaque, Amphibole, Pyroxene, Garnet, Chlorite, Epidote, Rutile, Zircon, Tormaline, Kyanite, Staurolite, and Biotite.

Results showed the percentages of the group of heavy metals, which ranged between (0.7 – 37.5%) with rate of (19.1%). The highest value was in the Bk_1 horizon in the second depth of the Pedon (9), and the lowest value was in the Bk horizon in the second depth of Pedon (7). Results (Tables: 1,2,3 and 4) showed that the most important diagnosed metals, in pedons soil of the current study, were opaque .They constitute high percentages of the heavy metal group which ranged between (29.7 – 37.5 %) with rate of (33.6%). The highest value was in the Bk_1 horizon in the second depth of the Pedon (9), and the lowest value was in the Bk horizon of the Pedon (1). The optical and microscopic characteristics (plate 4) showed that this group included iron oxides (magmatite), which appeared in black opaque, metallic brilliance under the inverter microscope, and irregular forms. While the hematite appeared irregular, semi-metallic, and had a red brown color. Within this group, there was chromite metal, which characterized by the black color and metallic brilliance; it was found in a small angular sizes, and sub rounded shape (Jawlkami, 2006).

Results showed the percentages of chlorite group, which ranged between (8.4 – 8.6 %) with rate of (5.8%). The highest value was in the Ap horizon in the first depth of the pedon (9), and the lowest value was in the A horizon in the first depth of the pedon (7). The metal (Plate 3) appears hexagonally had a green color with various degrees; it rarely had a yellow, red, or pink color and glass or pearly brilliance with hardness of 2.5 – 2 with specific gravity of 3/3 to 6/2 and crystallized within the monoclinic, sometimes triclinic system (Bossily, and muthafar, 1980). Ali (1976) indicated that the chlorite source , which was considered as one of the laminate metals, was the transformation of biotite ,amphibole, pyroxene, or primary minerals from metamorphic rocks in Iraq and Turkey or present in igneous rocks derived from hydrothermal variables (Jawlkami,2008).

The zircon was another group of the diagnosed minerals within the heavy metal in studied pedons soils. Zircon is one of the metals resistant to weathering. The percentage was (2.6 – 5.8%) with rate of (7.35%). The highest value was in Ck_1 horizon of the Pedon: (6), while the lowest value was in Bk_1 of the Pedon: (1). These low zircon percentages were attributed to the nature and variety of rocks origin in the sand fraction which were igneous alkaline, ultra-alkaline, medium, and metamorphic rocks followed by acidic igneous rocks (Milner, 1962). Microscope tests (Plate 4) showed that zircon was colorless, sometimes with blue or violet deep shadows, had euhedral – subeuhedral shape and the prismatic grains were common and rarely had sub-angular, had a diamond brilliance, the hardness was 7.5, and the specific weight of 4.68 (Kerr, 1959).

Garnite was also diagnosed within the soil pedons of the present study, it considered as one of metals that resistant to the weathering. Percentages ranged between (4.8 - 8.6%) with rate of (5.8%). Through microscope test (Plate 3), the metal was colorless, had hardness of 6 – 7, specific weight of 3.3 – 3.5, had a glass brilliance, and considered as one of chemical stable metals (Jawad, 1977). It resulted from metamorphic rocks, especially high transformation and ultra-alkaline igneous rocks.

Pyroxene menials considered as low weathering resistant metals representing one of magnesium sources in the soil. The percentages ranged between (4.2 – 8.6%) with rate of (5.5%). The microscopic examination (plate 4) showed that these metals were characterized by the green pale color, and prismatic rectangular particles whether ortho pyroxene or mono pyroxene (Jassim , 2009). The relative distribution of this group varied due to the nature of the mineralogical composition of the original material (Hussain and Kamaal, 2008). In addition, Amphiboles were diagnosed within the heavy metal group; Amphiboles is one of the heavy metals group derived from the weathering of metamorphic rocks and characterized by weak resistance to weathering. The presence of these metals indicated that the original area characterized by rapid transport and severe erosion, and physical weathering of the original rock was more influential than the chemical weathering (Saad, 1990). Their percentages ranged between (7.7 - 8.4%) with rate of (6.25%). Among the most important diagnosed minerals of this group is the hornblende metal (plate . 3) that characterized by the light green to green-brown color with a change in color and a clear detachable, had a glass brilliance, hardness of 5 – 6, specific weight 3.4 – 3, had prismatic rectangular shapes, edges appear as a result of mechanical abrasion during transport, and refers to the mineral hornblende gneiss metamorphic rocks (kerr, 1959; Nesse, 2000) and to acidic igneous rocks (pettijhon *et al.,* 1973).

The results also showed the presence of tourmaline within the heavy metal group with percentages ranged between (0.7 - 2.8 %) with the rate of (1.75%). Using a reflector optical microscope (plate 4), the metal was found as light brown color (brown hazel), circular shaped, equanat, had glass to resinous brilliance, hardness of 7.5 - 7, and specific gravity 3.2 - 3 (kerr, 1959 , Nesse, 2000). Furthermore, the Epidote is one of heavy metals that have medium resistance to weathering; these metals are sources of calcium ions in the soil (Al-Bayati, 1988). The percentage ranged from (7.4 - 8.6%) with rate of (5.75%).The metal microscopically (plate 3) characterized by a greenish-yellow color, sometimes had pale colors. Types varied according to the influence by transformation, (Heinrich, 1965 ; Michael , *et. al.,* 2011). The particles characterized in forms of semi-circular ring, prismatic, and sub equant (Jassim , 2009). The metal had a glass brilliant, hardness of 7-6, specific weight of 5.3 to 3.3 and inferred the existence of the original Epidote unstable rocks (Jawlkami, 2008; Folk, 1975).

Results also showed the percentages of Rutile metal that ranged from (1.3 - 8.1%) with rate of (2.45%). Microscopically, the metal was found (plate 4) red, turquoise, dark, angular - subhedral, with cracks, the hardness of 6 – 6.5 and specific weight of 4.21 (Harald, 2010).

The results showed the presence of Staurolite metal among metals diagnosed within the heavy metal group with percentages ranged between (2.2 - 6.3%) and the rate of (2.9%).This metal was characterized with yellowish-golden color, angular shape, a semi-glass brilliance, hardness of 7 – 7.5, and specific weight of 7.3 – 8.3. Kyanite also appeared with percentages of (5.1 - 9.2%) with rate of (2.2%). The metal was microscopically distinguished with colorless, and eahedral - equant shape with the presence of clear cracks (Milner, 1962; Harald , 2010).

The mica group was also among the heavy metals diagnosed in soils of the current study, Biotite metal of this group had percentages of (2.5 - 8.2%) with rate of (4%). The metal appeared under a polarized light microscopy (plate (3 and 4) in a green or dark brown to black color. It was rare to be light yellow, had

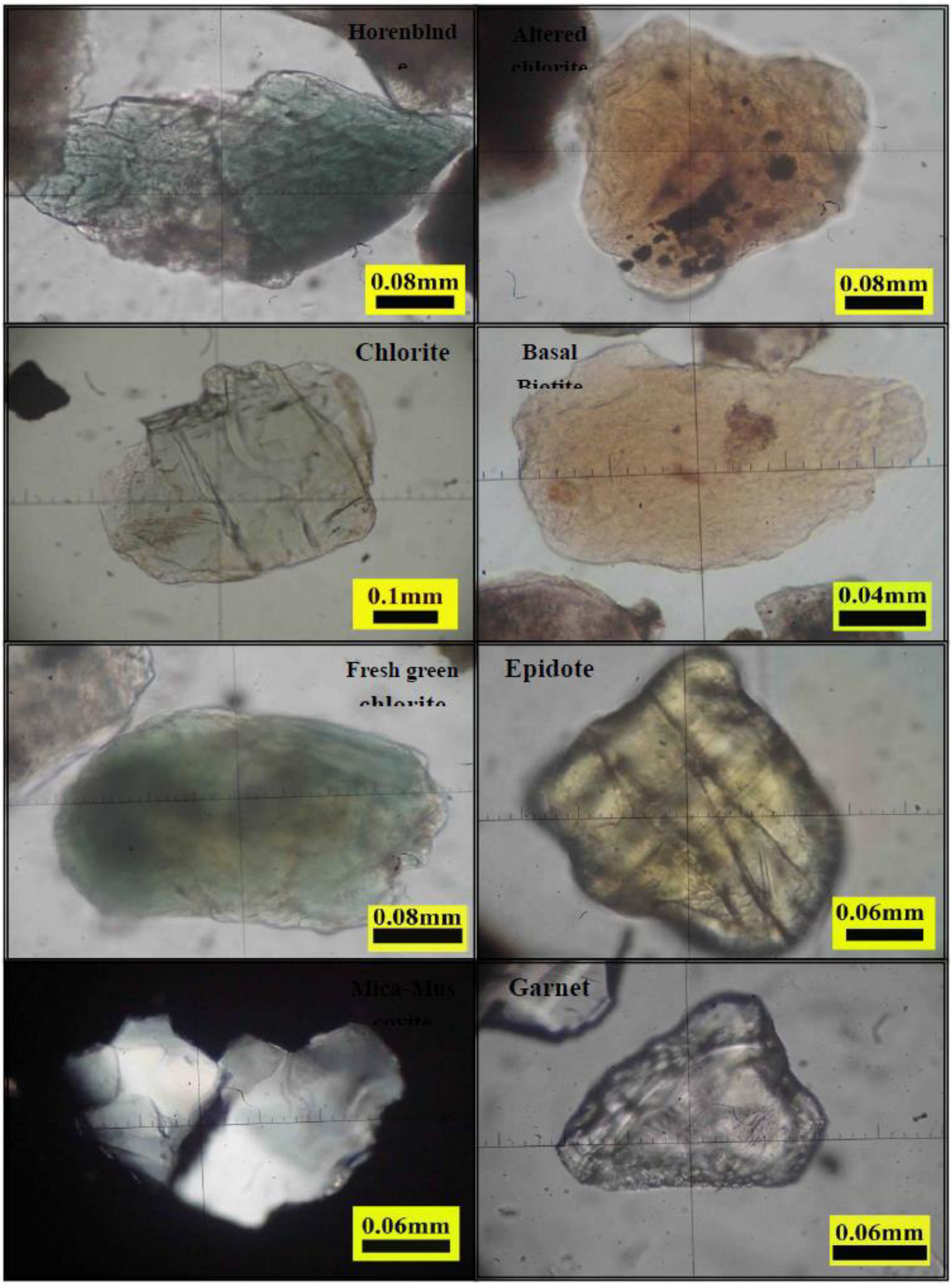

Plate 3. Photos of some heavy metals of soil pedons under polarized optical microscopy.

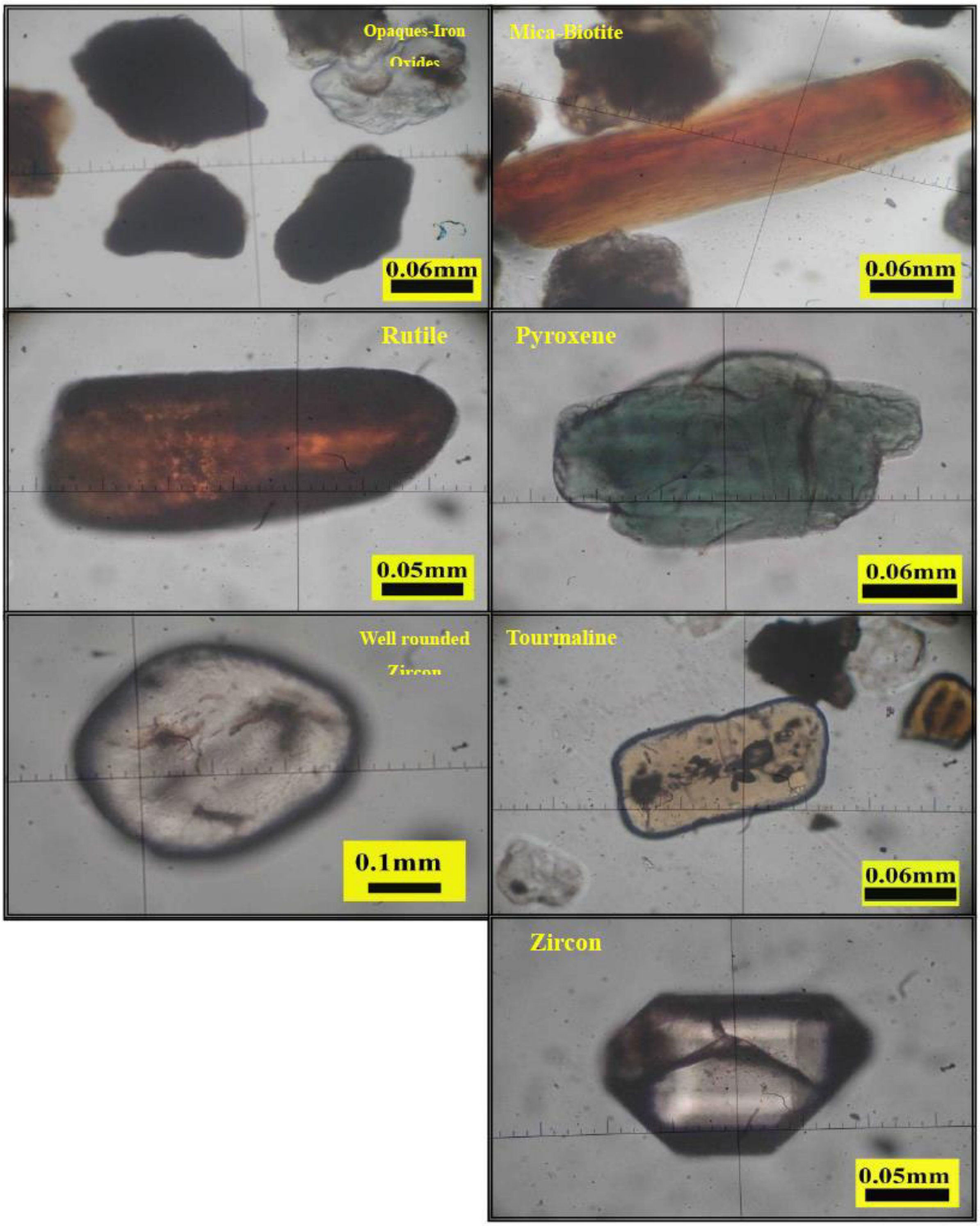

Plate 4. Photos of some heavy metals of soil pedons under polarized optical microscopy.

a glass brilliance, hardness 2.5 – 3, and specific weight of 2.3 – 8.2. It crystallized within the monoclinic system and found within the igneous rocks of acid and medium-sized rocks (Bossily and Muthaffar, 1980). Moreover, the muscovite which is one of the mica group diagnosed with percentages between (1.4 - 8.7%) with rate of (5.95%). Muscovite appeared under the inverter microscope (Plate 3) in different degrees of light green color , had flat crystals, hexagonal form, glass or pearly brilliance, hardness of 2 – 2.5, and specific weight of 22 – 3.3, had greasy touch and found within metamorphic rocks (Kerr, 1959; Nesse, 2000).

There was another group of minerals that included all secondary minerals resulting from weathering or diagentical. The percentages ranged between (5.1 – 5.3%) with rate of (2.5%). In general, the results showed low rates of the heavy metals group compared to the light metals group of sand fraction due to the nature of mineral composition of deposits source materials(Khafaji , 1979 ; Mhamid and Saleh, 2007).

The results also showed the similarity of heavy metals in terms of quality and quantity in different studied pedons soil, which showed their re-deposition (Maaleh *et al.,* 2008). A few of these source rocks unfolded in Zagros Mountains in northeastern of Iraq and the Taurus Mountains in southern Turkey (Brinkmann, 1976; Buday and Jassim, 1987).

Results showed the sovereignty of dark minerals group within the heavy metal group resulting from weathering and erosion of igneous and metamorphic rocks and which were rich with these minerals (Buda and Al-Hashimi, 1977). Mixing pedons (6 and 7) illustrated the highest percentages of dark metals compared to the rest studied pedons, it might be due to the impact of the Tigris River deposits on both sites. Abdul Amir , (1980) referred to the sovereignty of Opaque minerals in the sediments of the Tigris River, and Nadewii (1983) confirmed, in a study of some soils resulting from the deposition of the Tigris River in the alluvial plain, the sovereignty of dark minerals within the heavy metal group for those soils. Jawlkami (2008) mentioned that the low percentages of most of the heavy metals were due to the weakness of weathering processes, which referred to Staurolite, Kyanite, rutile, tourmaline, and the others led to the weakness of weathering processes and the rocks that formed the original material of the studied soils.

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