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Geochemical, Mineralogical and Biological study of Holocene deposits in Almuthana province, southern Iraq

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Abstract

Fifteen samples were collected from recent sediments grouping at 80 km east Samawa City, southern Iraq. Three selected samples for grain size analysis and twelve samples for chemical and biofacies analysis. Grain size analysis indicated that the sediment is mainly composed of the silt and clay with a small amount of sand. Most of the samples considered to be as clayey silt. The dominated non clay minerals are Quartz, Calcite, and Dolomite, while the clay minerals are composed of mixed Montmorillonite- Chlorite, Palygorskite, Illite and Kaolinite. Chemical analysis showed that all samples have high concentrations of SiO_2 and CaO in comparison with Al_2O_3, MgO, Fe_2O_3, K_2O and N_2O. The identified faunas consist of a number of groups such as Mollusca, Ostracoda and Charophyta, all diagnosed genera indicated of fresh water environments. The results from all collected data are indicated that the sediments belong to flood plain deposits which deposited in fluviatile environments.

Keywords: Holocene, recent fauna, Samawa Governorate, clay minerals.

دراسة جيوكيميائية ومعدنية وحياتية لترسبات عصر الهولوسين في محافظة المثنى، العراق

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الخلاصة

جمعت خمسة عشر نموجا من الترسبات الحديثة على بعد 80 كم من شرق مركز السماوة، جنوبي العراق، ثلاث نماذج تم تحليل التدرج الحجمي لها و 12 نموذجا لاجراء التحليل الكيميائي والحياتي. دل التحليل الحجمي على ان الرواسب متكونة من الغرين والطين مع كمية قليلة من الرمل، معظم النماذج صنفت على انها نماذج غرينيه طينية. اما اهم المعادن غير الطينية هي : الكوارتز والكالسايت والدولومايت، بينما المعادن الطينية تكونت من خليط من المونتموريلونايت – الكلورايت، و الباليكورسكايت والايت والكاؤولينايت. اما التحليل الكيميائي للنماذج بين تركيز عالي SiO_2 و CaO بالمقارنة مع Al_2O_3, MgO, Fe_2O_3, K_2O and N_2O . تشخيص المجاميع الحياتية بين بوجود مجاميع من الاحياء اهمها الرخويات والاوستراكودا والطحالب الذهبية، كل الانواع المشخصة دلت على انها عاشت في مياه عذبة، كل النتائج المجتمعه من جميع التحاليل دلت بان تلك الترسبات ترسبت في سهل فيضي ترسب نتيجة بيئات نهرية.

1. Introduction

A study of recent sediment provides the basis for defining the physiochemical and ecological setting of the natural environments and the changes caused to them by earth processes and anthropogenic

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activities [1]. Quaternary sediments of the Mesopotamian plain southern Iraq cover large areas of the unstable shelf.

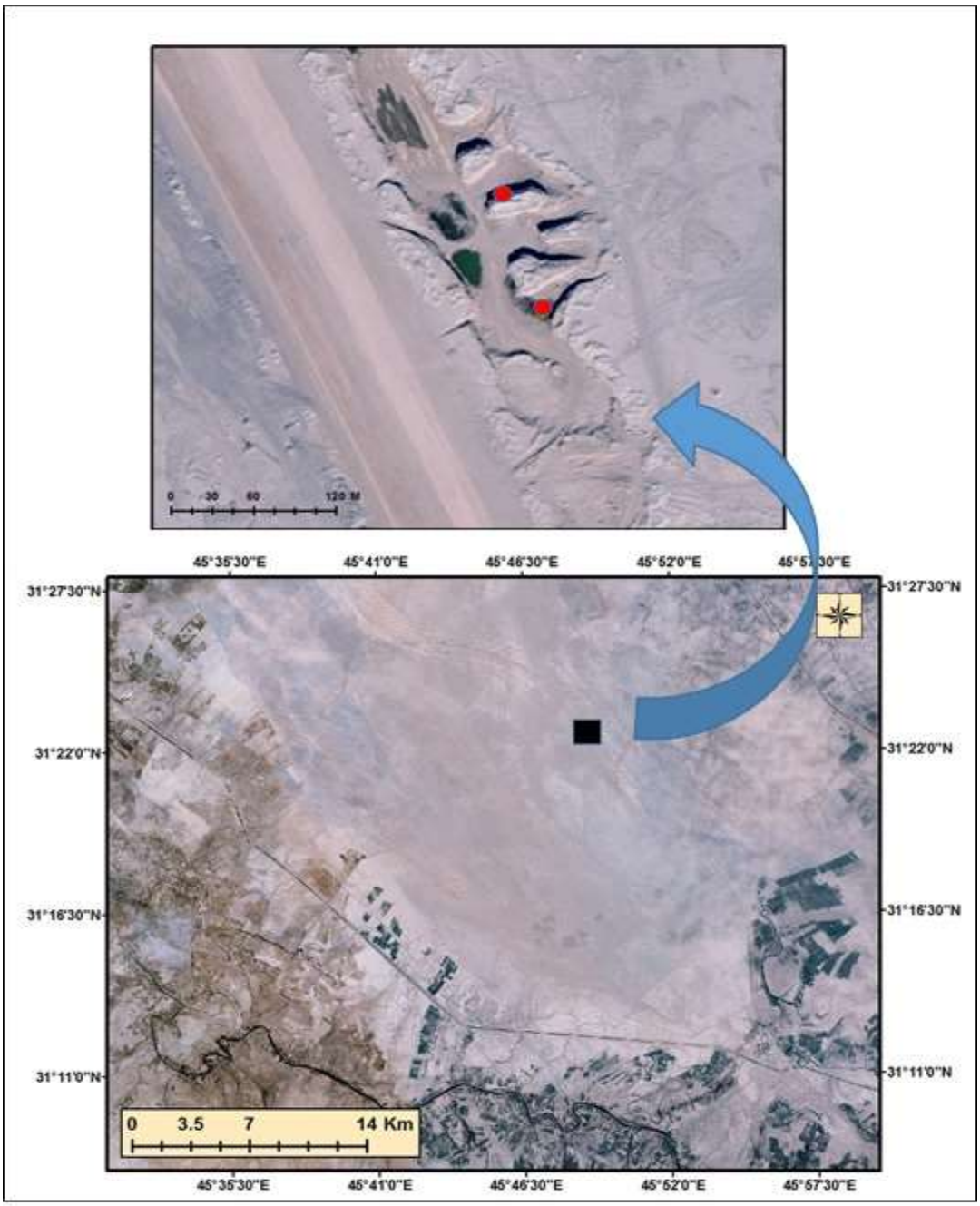


Figure 1-Map of study area at Samawa desert area, the red circles represent the selected surface sections.

The clay minerals refer to those sediments having earthly properties and become plastic when mixed with water, they consist of hydrous Alumino-silicates, Magnisum, Iron, Organic matters and soluble salts, which can be deposited in any environments, although the major deposition is river, flood plain, lakes, large delta, and the ocean floors. The aim of the current study is to detect the mineralogical, geochemical composition of recent sediment and fauna assemblages at selected surface sections within the desert of Samawa area southern Iraq.

2. Geological Settings

The study area is located 80 Km toward the east of Samawa city and about 50 Km west of Nasiriya city, between longitudes 45° 48 to 45° 55 E and latitudes 31° 22 to 31° 30 N Figure-1.

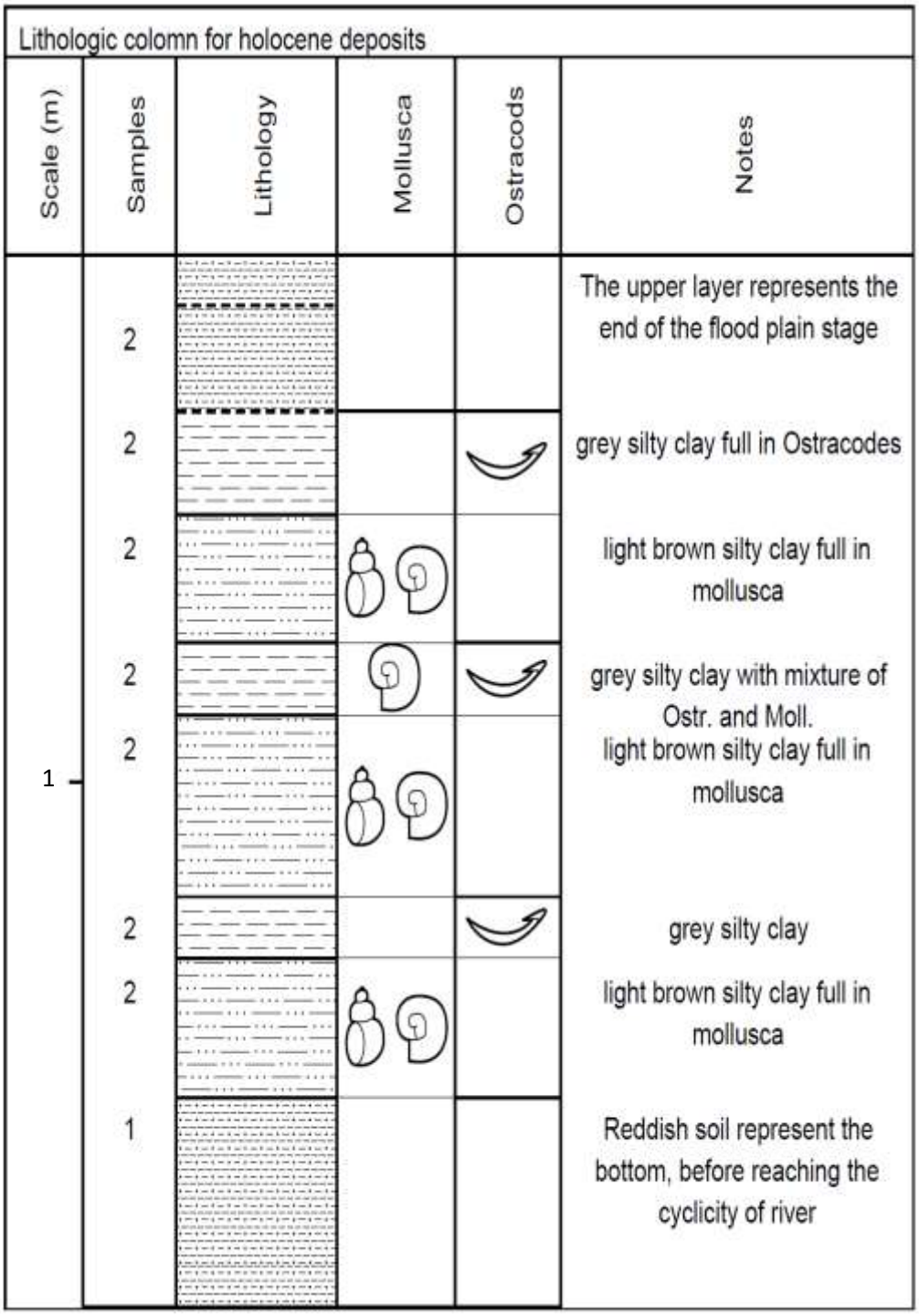


Figure 2-Lithological column in the studied area at Samawa area, Iraq.

The study area lies within Samawa – Nasiriya subzone, consist of Pleistocene detrital sediments, and appear as outcrop near the surface. The thickness of sediments is variable but is greater than 5 m in some sections. The area is flat with non-geomorphological feature except sand sheet which consists of some clays as quaternary deposits of the flood plain and soil deposits [2]. The soil of studied area formed of sand silt and clay with some gravel.

Figure 3-A-Lithologic column of studied section, the red boundaries represent the period of flood plain to the Euphrates River, B- magnifier bed to the accumulated of fauna (Mollusca shells).

3. Materials and Methods

Fifteen sediment samples collected from two selected sections of different thickness (3 m to more than 12m) Figures- (2 and 3). The distance between sections is about 1 km. The samples are divided into three parts, one of them to mineralogical analysis and the other for chemical analysis and fauna separation. The separation was done at College of Science, University of Basrah, by soak the sample with water for one night. As well as, three samples to grain size analysis. All samples were air dried and disaggregated by use an agate mortar. Grain size analysis is carried out to separate sand from silt and clay, using sieve (0.063) mm (230mesh) by wet sieving. The silt and clay fraction down ward from 230 mesh. Sieve was separated using sedimentation method [3]. Geochemical analysis of major oxides is performed for five samples using different methods in the laboratories of the state of the Iraqi geological survey according to Table-1.

Table 1-Methods of chemical analysis to the current study

Oxides	Methods of analysis
SiO_2	Gravimetric Method
Al_2O_3	Colorimetric Method
Fe_2O_3	Atomic Absorption Spectrometry
CaO, MgO	Volumetric Method
K_2O, Na_2O	Flame Photometry

Mineralogical analysis of the samples was determined by using XRD analysis type Panalytical X pert PROMDP with Ni filtered and Cu radiation at the department of Physics, University of Basrah. Clay and non-clay minerals were identified in sediments samples according to [4].

The faunas were extracted by washing and sieving techniques depending on [5], 36mm and 100 mm sieves that used in separation faunas, then picked by binocular microscope.

4. Results and Discussion

4-1. Grain size analysis

The results of the grain size analysis are given in table 2 for three selected samples, which show the percentages of sand, silt, and clay. Clay was low percent in selected samples 21.08 to 30.15 % with an average of 26.52%, while the silt portion is high percent in all samples, it ranged between 61.4 to

74.42 %, whereas the sand percentage is the less in all samples which varied from 4.5 to 8.6%. The results indicated that the sediments were deposited at low energy conditions [3].

Table 2-Results of grain size analysis that selected from section 1, Samawa area

Section 1	Sand %	Silt %	Clay%
Sample -1	4.5	74.42	21.08
Sample -2	8.6	61.4	30.15
Sample -3	7.5	63.7	28.35
Average	6.87	66.50	26.52

4-2. Mineralogical analysis

4-2.1 Non-clay Minerals

The non-clay minerals have been identified by XRD powder technique at the range of angle 2 θ between 2 -60 °, Calcite and Quartz are the dominated minerals in all samples, characterized by the reflection of 3.03 A° , 3.36 A° , 1.91 A°. Quartz identified at 3.34 A°, 4.26 A° and 2.45 A° respectively with trace of Dolomite and Feldspar (Fig. 4). The high percentage of Calcite in samples is related to the calcitic composition of shells of Mollusca and Ostracod, which were found within sediments, whereas the high content of Quartz is due to the high proportion of silt in sediments.

4.2.2. Clay Minerals

Generally, clay minerals showed diversity and complexity in their mineralogy and structure due to their small particle size and occurrence in low or different crystalline degrees, in addition to their deferent chemical composition [6]. The X-Ray analysis of clay fraction samples are shown in Fig 5, these are:

1. Mixed layers Montmorillonite – Chlorite

Mixed layers can form under weathering involving the removal of hydroxides interlayering [7]. Montmorillonite – Chlorite is common in the study area which appears at reflections 1.5 A° and 4.97A°, the existence of mixed Montmorillonite – Chlorite layer indicated that the sediment of the current study is formed under humid conditions [8] (Figure-5).

2. Palygorskite and Illite

Palygorskite is rare fibrous clay minerals and it is stable if associated with Montmorillonite. Palygorskite is characterized at 10.5A° and it is increased with the increases of salinity and silica. The origin of Palygorskite either authigenic or detrital [6]. Illite was formed by direct weathering and erosion of alumino silicates and may be from the alteration of Montmorillonite in the study area, Illite characterized by reflection 10.0A°(Fig.5).

3. Kaolinite

Kaolinite was derived from weathering of K-feldspar of acidic igneous rocks, and have a fluviatile origin in the study area, it is characterized by reflection 7.1 A° and 3.57A° reflections (Fig.5).

In conclusions, the assemblages of clay mineralogy gave an indication and believed that most of the clay minerals are of detrital origin and deposited in fluviatile environments.

4-3. Geochemistry

The concentrations of major oxides SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, Na_2O, K_2O and L.O.I (Loss on ignition) are given in table 3. The chemical compositions of the studied samples change relative to their mineralogical composition.

SiO_2 is the main constituent of all samples and is the highest percentage of the total Oxides in all samples it ranges from 38.6 to 42.13% with an average of 40.21, this is mean that the calcite and Quartiz are the predominant minerals in sediments.

The Aluminum oxide (Al_2O_3) is nearly constant in all sediments ranges from 8.61 to 10.1% with average 9.42%, while the Iron Oxide (Fe_2O_3) ranges between 2.31 to 4.8 % and average 3.53%. The Magnesium Oxide has averaged between 3.2 to 3.92% and these values are related to dolomite and palygorskite. The concentration of CaO ranges from 18.2 to 20.17% and 19.14% as an average, it is related to Calcite, Dolomite and Montmorillonite –Chlorite mixed layer which appears in XRD pattern Figure-5. The percentages of NaO ranges between 0.91 to 1.05 % with an average 1.02%, where the K_2O ranges between 1.02 to 1.32% with averages of 1.24%, K_2O is corrected to illite and feldspar. LOI is related to the high percentage of carbonate organic matter, free and crystalline water and CO_2 contents during ignition.

Table 3-Oxides percent in the studied area, Samawa area

Element / Samples		SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	L.O.I	Total
Sec-1	1	42.13	8.61	2.31	18.2	3.2	1.05	1.21	22.8	99.51
	2	38.6	9.8	4.12	19.3	3.55	1.14	1.30	21.3	99.11
Sec-2	3	40.7	10.1	3.11	20.17	3.92	0.96	1.34	20.1	100.4
	4	39.53	8.94	4.80	18.78	3.40	0.91	1.33	21.7	99.39
Sec-3	5	40.11	9.66	3.32	19.28	3.70	1.05	1.02	22.8	100.9
Min		38.6	8.61	2.31	18.2	3.2	0.91	1.02	20.1	
Max		42.13	10.1	4.80	20.17	3.92	1.05	1.34	22.8	
Average		40.21	9.42	3.53	19.14	3.55	1.02	1.24	21.75	

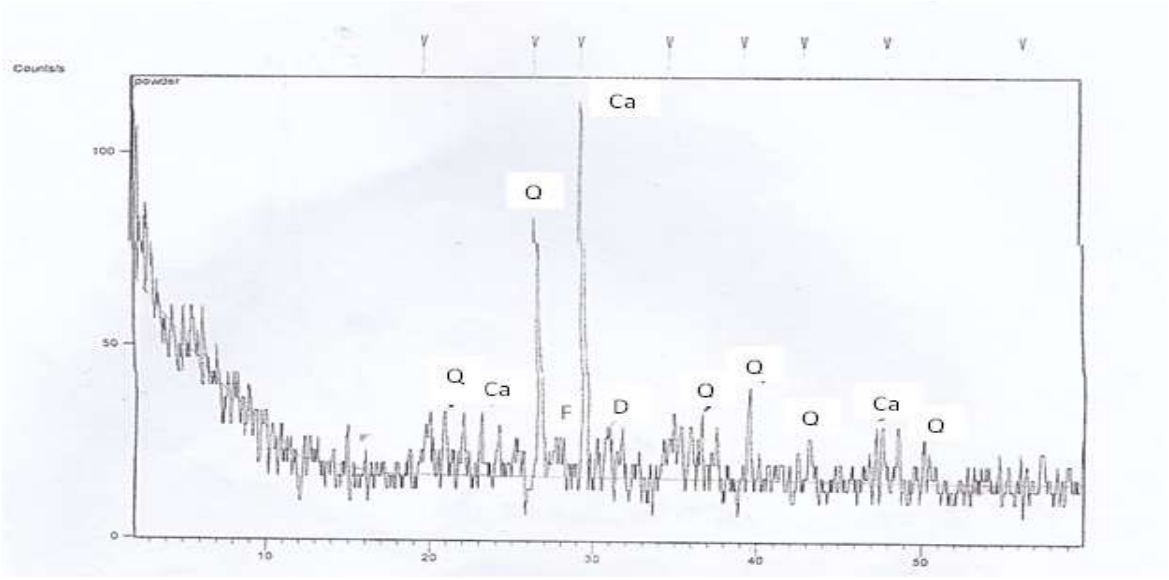


Figure 4-XRD pattern of bulk sample (sample-1), Samawa area, Q=Quartz, Ca=Calcite, F=Feldspar, D= Dolomite

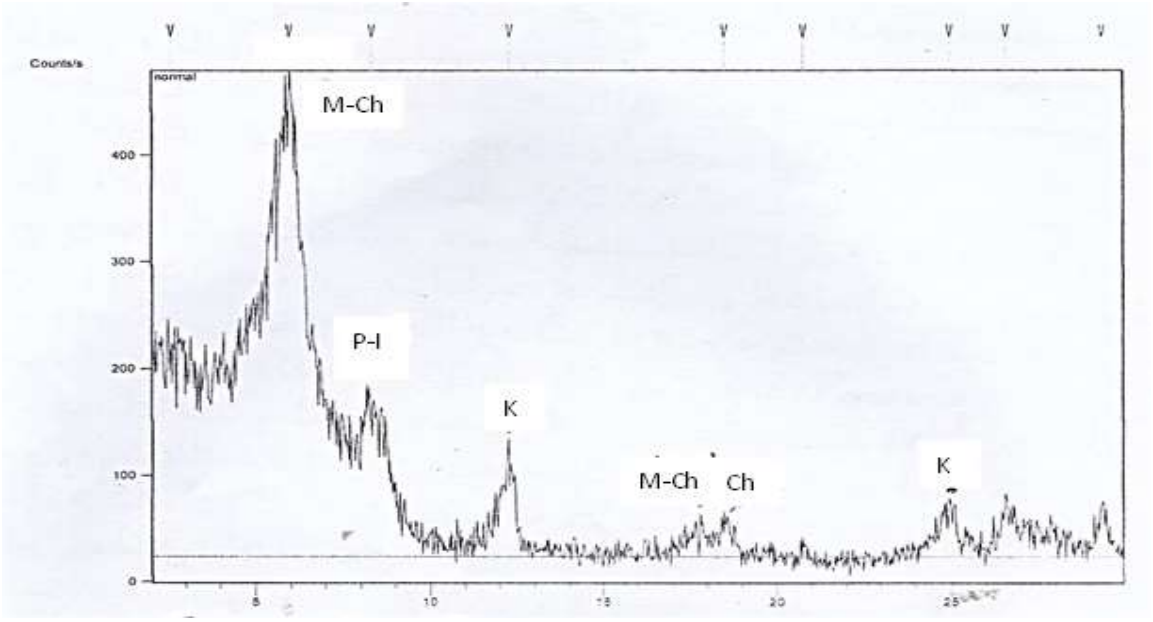


Figure 5-XRD pattern of oriented sample (sample-1) 2 micron clay minerals, Samawa area, M=Montmorillonite, Ch=Chlorite, K=Kaolinite, P=Palygorskite, I=Illite.

4-4. Fauna assemblages

The important assemblages in the studied area are Mollusca (Bivalve and Gastropods) with Ostracodes, the study is free of Foraminifera. Although the small studied area but it rich in the fauna, these are:

1. Pelecypods: the studied area is identified one species only, Anodonta cygnea (*Unio* sp or swan mussel). With small size (1 mm) and pale color, these species reflect a fresh water environment (Pl.1-1).

2. Gastropods: three genera were determined in the present study, these are: *Gyraulus* sp (family Planorbidae) , *Lymnaea* sp. and *Stagnicola* sp. The two species belong to family Lymnaeidae which consider an air-breathing freshwater snail, these snails live in shallow, well-aerated freshwater habitats. All identified species are reflected fresh water environment, like the rivers and ponds [9], [10], (Pl.1-2, 3 and 4)

3. Ostracods: it presents the most fauna diversity in the region, with vast numbers. Seven genera were identified in the studied area, these are: *Cyprideis torosa*, *Cyprideis torosa var.torosa*, *Candona neglecta Sars*, *Candonilla wanlessi*, *Darwinula stevensoni* (Brady & Robertson), *Ilyocypris* SP., *Cyprinotus salinus*(Brady). These ostracods represent a typical environment of fresh water, with oligohaline zone [11], [12], (Pl.1-5 and 6) (Pl.2-1, 2, 3, 4 and 5).

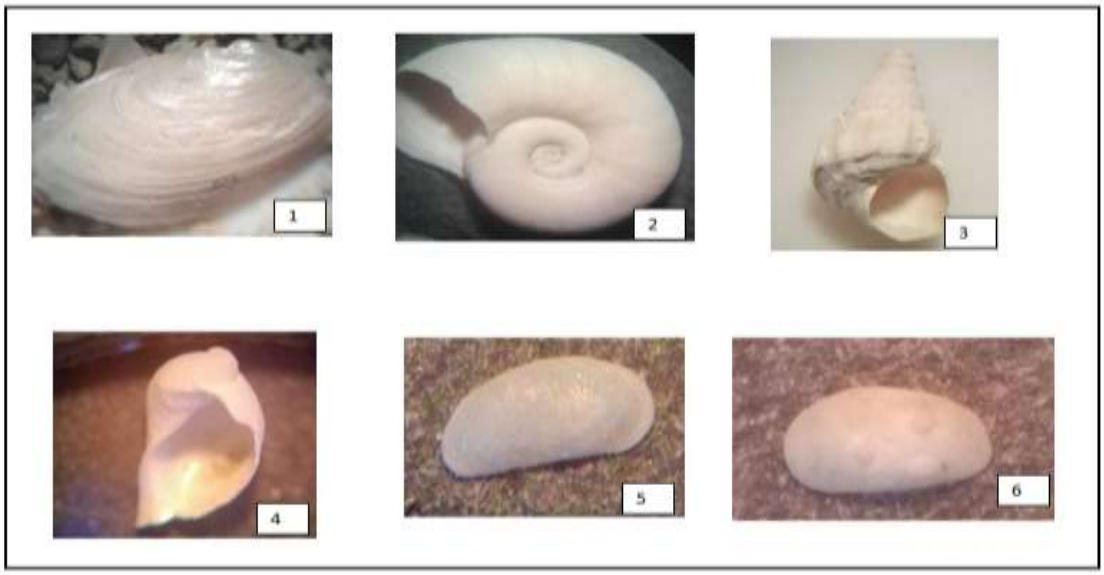
4. Charophyta it is one of the important type of algae, the Charophyta exists in numerous places such as quiet shallow of fresh or brackish water [13] (Pl.2-6).

A flood plain is an area of terrestrial that nearby to the river which expanses towards banks, during of increased the discharge to the water by flooding lead to composed these plains. The beds comprise of levees, silts, and sands deposited [14].

The sedimentary cyclicity of the studied section is represented by river deposits related to flooding of Euphrates River. The studied fauna analysis revealed the absence of foraminifers and hence the absence of diversity to the other fauna, such as bivalve.

The floodplain during its deposition is marked by the meandering of Euphrates River (Fig. 1) and is completely covered with water. When the drainage system changed by fill or over fill to the river channel, the percent of spilled sediments will change. In the studied area six cycles are characterized the section, the maximum of cycle is 50 cm which reflect high level flooding to the river with mixture of fauna, while there is a thin cycle with thickness 20 cm.

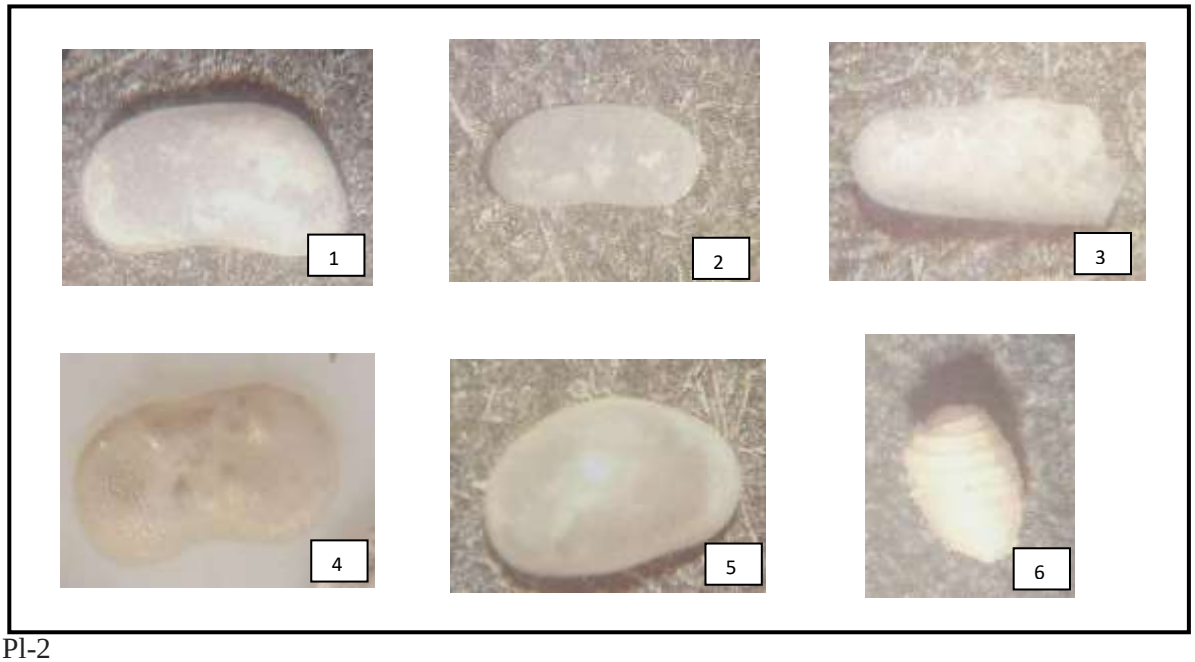
Plate -1



Pl.1

1- *Anodonta cygnea* 20X
2- *Gyraulus* sp. 40X
3- *Lymnaea* sp. 20 X
4- *Stagnicola* sp 20X
5- : *Cyprideis torosa* 50 X
6- *Cyprideis torosa var.torosa* X50

Plate -2



Pl-2

1. *Candona neglecta Sars* 50 X
2. *Candonilla wanlessi* 50 X
3. *Darwinula stevensoni* 50 X
4. *Ilyocypris* SP. 50 X
5. *Cyprinotus salinus* 50 X
6. *Chara canescence* (Charophyta) 50 X

5. Conclusion

1. Grain size analysis shows that silt is the main component of sediment with less proportion of clay and sand. So most of sediment consider as clayey silt.
2. Montmorillonite- chlorite, palygorskite, illite and kaolinite are the main type of clay minerals in all studied samples, they result from weathering of sources rocks and deposited as flood plain deposits in fluviatile environments.
3. All samples have a high percentage of SiO_2, CaO in comparison with Al_2O_3, MgO, K_2O and Na_2O which controlled by the mineralogy of sediments. The high percentage of Calcite belongs to assemblages of Mollusca (Pelecypods, Gastropods) and Ostracods, whereas the high content of Quartz related to occur of silt in sediments.
4. One species of pelecypods was identified, as well as three genera return to gastropods, seven genera were diagnosed return to ostracods, it presents the most fauna in the studied region.
5. All diagnosedfauna reflect a typical fresh water environment, At that time the water in the Euphrates river was very different from what it is now, it very fresh. The Euphrates River has received equal periods of flood, it looks in the form of cycles, either thick beds (50) cm or thin (20) cm.

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