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Sedimentology and mineralogy of the Al-Hammar Marsh / Southern Iraq: A review

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Abstract

The sediments of Ahwar area are mainly clayey silt with small amount of sand. The sand fraction is of fine to very fine grains. The color of these sediments is influenced by the hydrodynamic nature of the environment, and the organic content. The surface sediments are divided into three main layers; a surface organic – rich sand silty layer to a depth 7cm, shelly clayey silt layer from 7 to 30cm in depth, and silty clay or/and clay layer more than 30cm in depth. The dominant sedimentary structures are bioturbation and lamination. The heavy and light mineral assemblages reflect the origin of these sediments which is the ancient outcrops transported by Tigris and Euphrates Rivers. Low – Mg calcite, High – Mg calcite, dolomite and gypsum minerals are also present and considered as authigenic minerals. The detected clay mineral assemblage is smectite, chlorite, illite, mixed layer illite-smectite and kaolinite, in addition to palygorskite as authigenic and allogenic mineral.

1. Introduction

Ahwar is a low land area covers the major part of the southern Mesopotamian plain. It consists of many lakes as Al-Hammar, Baghdad, Zecheri, …etc. The largest one of these lakes is Al-Hammar (Fig. 1). This area is a subject to many studies of different field of interest; historical, geological, biological, chemical …etc. But, this area still needs to a large multidisciplinery studies to evaluate the scientific, economic and tourism value. Ahwar

area suffered in the last decade from a desiccation period owing to political reasons, extended from ninetieth to early 2003 led that Ahwar, to be limited in occurrence, to local and disseminated just around and near the main rivers to about 10% of its original size. After 2003, the Ahwar was rehabilitated and started to return its normal size gradually.

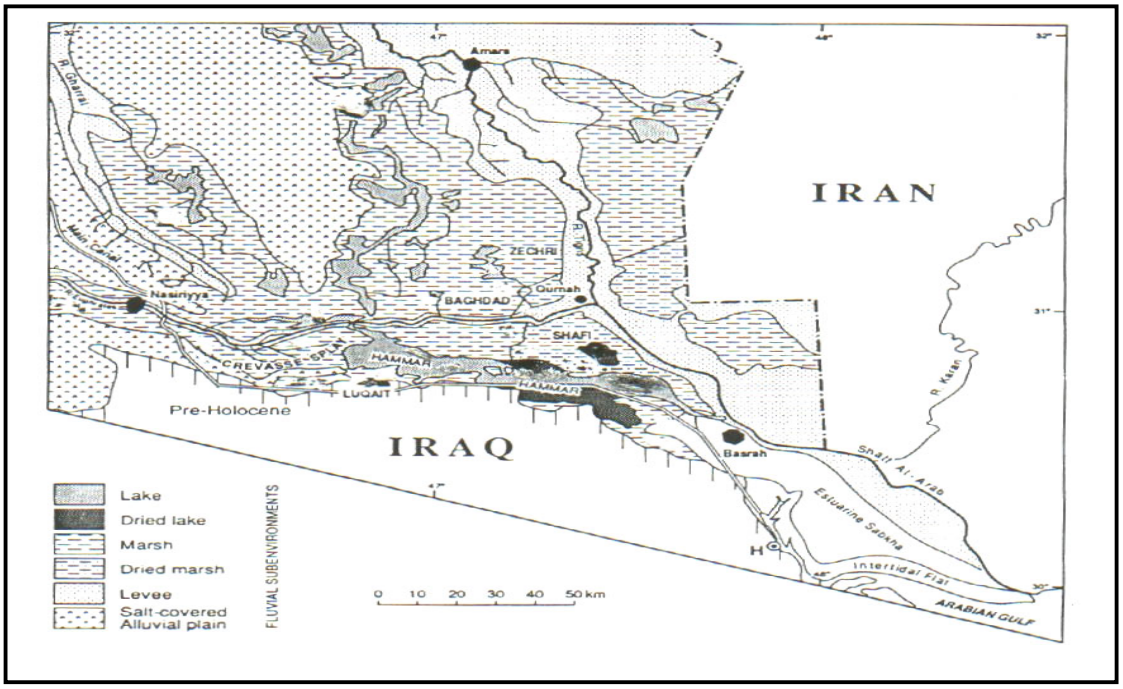

Fig. 1- Location Map, (after Aqrawi & Evans, 1990).

2. Geology and History of the Area:

The geologic history of Ahwar area is a matter of discussion from many years. Lloyd (1943) suggested that the Arabian Gulf before 4000 years B.P. was reached Sammarah north of Baghdad on the Tigris and Hit on the Euphrates Rivers. Then, the gulf was retreated due to the huge amounts of sediments transported by these two rivers. The distance of retraction is about 680 km. This suggestion is contradicted with the historical and archaeological investigations, which stated the presence of Al-Ubaid civilization near Erido city at 5000 years B.P.(Susa, 1983), and the irrigation channels are an evidence of that period, which means that the Ahwar area was cultivated before 3000 years B.P. This old civilization represents the period of protoliterate occupied the hill and elevated area during period that extend from the end of fifth to the end of fourth thousand years B.P. It localised in the Hammar Lake between Tel Al-Lahim south of Ur to Basrah. Near Ur city, there is a site which called " Dakdaka" shows traces of old barrage to block water for cerain level and then distributed to the small branches of Euphrates River (Susa, 1983), it is

suggested that the barrage was constructed during the end of third thousand year B.P.

Based on Cullen et al.(2000), the Mesopotamian plain was a subject of aridity and dust supply during the hyper arid last glacial maximum. This arid condition happened during 4025 ± 150 years B.P.

An another evidence is the path of Euphrates River where it discharged directly to the Arabian Gulf passing through old city of Ur and recent Khor Al-Zubair, and to the south of Hammar lake on the western side of Shatt Al-Arab River, there were traces of many old irrigation channels. A huge flooding of the two rivers during 629 years A.P followed this period, destroying all the dames and main river projects and changing the river channels. After this flooding, the southern part of Mesopotamian plain becomes large lakes and broaden Ahwar continued to the gulf (Susa, 1983). This area stay as it is even it received a large quantity of sediments by the two rivers.

DeMorgan (1900) suggested that the Ahwar area was a finger from the Arabian Gulf, then isolated by the transported sediments of Al-Karkha River in the east and alluvial fan deposits of Wadi Al-Batin in the south west. Lees and Falcon (1952) proposed a tectonic hypothesis to explain the Ahwar nature. Their hypothesis says that the Ahwar area subsidence continuously due to the transported sediments of the two rivers and the collision between Arab and Iranian plates help in this subsidence, consequently, all the cities and old civilizations were immersed by water. All the recent hypothesis are agree with the tectonic events, which are activated especialy during the last uplifting of Al-Zubair anticline, and consequently changed the river flow – way of Euphrates and Ebu Al-Khassib Rivers (Al-Sakini, 1993).

3. Sediment texture of Ahwar Area:

The major part of sediments cover the Ahwar area composed of sandy clayey silt and clayey silt with small amount of clay-silt and sandy clay-silt (Abdullah, 1982). The clay percent increases with depth especially after about 30 cm depth (Aqrawi, 1993a). The silt fraction represents the principle component in the Ahwar sediments range between 48 - 82% with average 68%. The second fraction is the clay which ranges between 2 - 40% with average 22%, whereas, the sand fraction is between 0.3 and 32% with average 10%, this sand fraction is of fine to very fine grains (Abdullah, 1982 and Aqrawi, 1993a).

Ahwar area is influenced by dust fallout, which is clayey sandy silt, dust fallout and alluvial sediments are calcareous in nature. Foda et al. (1985) observed that the northern part of the Arabian Gulf receives about 0.8 mm yr^{-1}.

The organic contents of sediments and the state of oxidation play an important role in their coloration, therefore, the sediment colors vary from greenish gray to dark color with depth, light olive, bluish and yellowish gray sediments are also presents. Blackish organic-rich sediments in the surface to a depth 10cm is limited in some locations.

4. Succession of Lithology:

Ahwar beds are mainly covered by recent loose sediments, vary in texture, color and mineral composition from one site to another, however, Aqrawi and Evans (1994) have been classified these beds into three main layer types, from top to bottom:

1. A surface organic-rich sand silty layer. This layer is thin it does not exceed 7cm in depth. Naturally, this layer contains all the organic remains of plants and its color ranges from black to dark gray or olive.
2. A shelly clayey silt layer with mollusc shells, dominated by *Corbicula* sp. And *Bellamya* sp. (in the upper parts) and *Melanoids* sp. And *Melanopsis* sp. (in the lower part). The depth of this layer is 7-30cm.
3. A silty clay or/and clay basal layer, its depth is more than 30cm, the fine sand and coarse silt fraction are mainly composed of foraminifers and ostracods.

This ideal succession varies from site to site and it is possible to find two of these layers only.

5. Sedimentary Structures:

Ahwar area represents a calm sedimentary environment. This calmness and their fine and very fine sediments permit the initiation of the unique sedimentary structures of these conditions. The main representative sedimentary structures such as; the bioturbation and the lamination. Fine sediments and shells fill the burrows (Aqrawi and Evans, 1994). The lamination is found in few localities in the deeper clay-rich layers near riverbanks. Naturally, the presence of this lamination is disturbed by the action of bioturbation as the most common sedimentary structure and plant roots.

6. Faunal Assemblages:

The fine sediments of the area under study are rich in numerous molluscs, which are the dominant of macrofauna. Three families are present; Corbiculidae, Thiaridae and Viviparidae (Purser, 1983 and Aqrawi and Evans, 1994). The genus are *Bellamya* sp., *Corbicula* sp., *Unio* sp. And *Lymnea* sp. Many factors cooperate in the distribution and abundance of this fauna such as water chemistry, salinity and temperature. The Mesopotamian freshwater malacofauna belongs to the Mediterranean palearctic domain (Plaziat and Younis, 2005). The most diverse malacofauna exists in rooted vegetation of lacustrine bottom sediments. The molluscan shells are more abundant on the floor of the

marsh channels cleared for boat traffic than they are anywhere else. This is due to the good oxygenation, low rate of sedimentation, and nutrient input(Plaziat and Younis, 2005).

Foraminifers, ostacodes and diatoms dominate the microfauna. The most common genuses are; *Ammonia becarii* of foraminifers (Aqrawi and Evans, 1994). This genus reflects the very brackish environment (Murray, 1991). The other abundant genus are *Cyprideis torosa*, *Limnonythere* sp. and *Darwinola* sp. of ostracod. These genuses are typical of fresh-brackish environment (Murray, 1991 and Aqrawi and Evans, 1994). According to Aqrawi and Evans (1994), the occurrence of *Ammonia becarii* and *Cypridies torosa* reflects the Ahwar area is influenced by marine conditions during the deposition of the clay-rich horizon in the depth more than 30cm. Also, they stated that the central part of Hammar Lake was a wide brackish-marine nearshore or lagoon environment bordered by coastal marshes to the north towards the rivers and by marginal sabkhas to the west during the latest part of the Holocene. The radiocarbon dates that the age of clay-rich horizon (more than 30cm depth) is more than 3000 y B.P., whereas, the second shelly horizon (between 7 and 30cm depth) is 3000yB.P. And the surface organic-rich horizon is 400y B.P. (Aqrawi and Evans, 1994).

7. Mineralogy of Ahwar Sediments:

A. Non-clay minerals:

It is well known that the sand is less abundant than silt and clay in the Ahwar sediments. Many mineral assemblages were identified. The heavy mineral assemblages are the same in the all sites (Table-1), but with different percentages (Abdullah, 1982).

Table(1):

Heavy mineral percentages in Ahwar area.

Heavy Mineral	Range %	Average %
Opaque minerals	14 – 29	22
Amphibole Group	11 – 25	18
Epidote Group	11 – 23	17
Pyroxene Group	12 – 25	17
Chlorite	4 – 10	7
Garnet Group	2 – 7	5
Biotite	1 – 6	3
Muscovite	1 – 3	2
Sphene	1 – 3	2
Zircon	1 7	2
Rutile	1 -4	2
Apatite	1 – 4	2
Tourmaline		1
Olivine,Staurolite, Kyanite, Spinel, and Andalusite		1

The heavy minerals in Ahwar sediments are dominant by opaque minerals, and amphibole group are represented by hornblende tremolite and actinolite and rarely glaucophane. Epidote group represented by epidote, zeosite and clinozeosite. Pyroxene group of orthopyroxene and clinopyroxene represented by augite, diopside, anastatite and hypersthene (Abdullah, 1982). The first four groups form more than 70% of heavy minerals in Ahwar sediments. It is believed that the heavy minerals were derived from the ancient igneous and metamorphic rocks cropping out in the north

and northeast, transported by Tigris and Euphrates Rivers, furthermore some of heavy minerals derived from the western desert transported by the valleys and ephemeral rivers.

The percentage of light minerals is greater than that of heavy minerals. The light minerals are dominated by carbonate (Abdullah, 1982)(Table-2).

Table (2):

Light mineral percentages in Ahwar sediments.

Light Mineral	Range %	Average %
Carbonate	35 – 82	60
Quartz	6 – 37	16
Feldspars	2 – 18	10
Chert	2 – 9	5
Chlorite		4
Muscovite		2
Biotite		1

The carbonate content within these sediments reaches 80% in fresh water skeletal-rich sediments (Abdullah, 1982; Purser, 1983, and Aqrawi and Evans, 1994). Owing to Abdullah(1982) the carbonates are originated from:

1. Molluscs and skeletal of calcareous animals, and the mean percentage is 26.6.
2. Detrital carbonate grains, with mean percentage is 46.5.
3. Carbonate rock fragments as micrite and microsparite, with mean percentage is 46.6.

The high percentage of carbonate could be related to the carbonate detritus derived from the outcroped limestone formations and transported by Euphrates River.

Low-Mg calcite presents as detrital grains, and it could be developed and also formed as authigenic in brackish environment. High-Mg calcite found in microcrystalline rhombs as authigenic mineral.

Aragonite is also present in shell fragments, shows no evidence of authigenic origin. Dolomite exist in forming of euhedral rhombs, this mineral is considered to be authigenic in origin (Abdullah, 1982 and Aqrawi and Evans, 1994). Gypsum occurs as euhedral crystals restricted to saline surface, also euhedral crystals of pyrite present in the upper organic-rich sediments as an authigenic mineral.

B. clay minerals:

Ahwar sediments are characterized by the occurrence of clay mineral assemblage, these minerals in descending order of amount are; smectite, chlorite, illite, mixed layers illite-smectite, palygorskite, and kaolinite (Abdullah, 1982 and Aqrawi and Evans, 1994). Illite and chlorite are alternatively change between each other in the relative order. Kaolinite present in all of the sediments but in little amount.

Aqrawi (1993a) stated that the clay mineral assemblage of Holocene sediments in fresh water lakes of Baghdad and Zechri in descending order; smectite, mixed layer illite-smectite, illite, palygorskite, kaolinite and chlorite. In brackish Water Lake Hammar the assemblage in descending order is; smectite, mixed layer illite-smectite, palygorskite, illite, kaolinite and chlorite.

The palygorskite in the Ahwar is both detrital and authigenic in origin. It covers mostly the dolomite crystals with presence of gypsum which is indicative of the authigenic origin (Aqrawi, 1993b). This formation of palygorskite occurs in hypersaline, alkaline, and Mg-rich environment in the Holocene sediments (Aqrawi, 1993b and Albadran and Hassen, 2003). This means that the Ahwar area survives an arid with evaporitic conditions favourable by the presence of calcareous sediments.

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/ جنوب العراق: دراسة مرجعية هور الحمار رسوبية ومعدنية

بدر نعمة البدران

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الخلاصة

تتكون رواسب منطقة الاهوار أساسا من الغرين الطيني مع كمية قليلة من الرمل. وان حبيبات الرمل هي من نوع الرمال الناعمة إلى الناعمة جدا. تتأثر ألوان هذه الرواسب بالطبيعة الهيدروديناميكية للبيئة ومحتوى المواد العضوية. تقسم الرواسب السطحية إلى ثلاثة طبقات رئيسية؛ الطبقة الغنية بالمواد العضوية والغرينية الرملية إلى عمق 7 سم، وطبقة الأصداف من الغرين الطيني وعلى عمق من 7 إلى 30 سم وطبقة الطين الغريني أو/و الطين وعلى عمق اكبر من 30 سم. تتمثل التراكيب الرسوبية الشائعة بتراكيب التصفح والتشوه الاحيائي. كما تعكس تجمعات المعادن الثقيلة والخفيفة طبيعة المصدر للرواسب والذي يمثل مكاشف الطبقات القديمة والتي نقلت خلال نهري دجلة والفرات. يعتقد أن بعض المعادن مثل الكالسايت العالي والواطيء المحتوى من المغنيسيوم والدولومايت والجبس على أنها متكونة في المكان. ظهرت المعادن الطينية مثل السمكتايت والكلورايت والالايت والمعادن الممتزجة من الالايت والسمكتايت وكذلك الكاؤلينايت بالإضافة إلى الباليكورسكايت كمعدن منقول ومتكون في المكان.