Biofacies and sedimentary environments of recent sediments of southern part of Mesopotamian plain

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Received 5/11/2002, Accepted 10/5/2005

Abstract

Three boreholes were chosen, these boreholes were and distributed around Basrah region southern part of Mesopotamian plain. The depth of there boreholes ranged between 27 and 30 meters. Faunal assemblages have been identified. Two biofacies and one lithofacies have been identified; from top to bottom, biofacies A as a surface layer in the southern extremity of Mesopotamian plain. It could reflect a local transgressive period. Biofacies B underlied the first biofacies, it covers the southern part of Mesopotamian plain, this facies could indicate a subsidence period and let the environment to be isolated marked by reduction associated with pyritization. The lithofacies C underlied the second biofacies, it is observed in the southern part of Mesopotamian plain. The funa was completely absent in this biofacies and combined with the presence of gypsum grains, which means that the evaporation was high. The vertical and lateral distribution of these biofacies could be highly attributed to tectonic events in this study area.

Introduction:

The paleontological study is an important discipline in identifying the environments of deposition. In Quaternary period, many invertebrates were used for this purpose, and proved by C-14 method.

The faunal information is deemed useful to help interpret energy levels and seafloor erosion [1]. Woodroff et al. [2] studied the mollusks of Late Quaternary period in Tasmania Sea, west of Australia. In the southern part of Mesopotamian plain, selected fauna used to record the sea level changes during the latest Pleistocene and Holocene[3].

The present work aimed to study the distribution patterns of faunal assemblages including foraminifera, mollusks and ostracoda along selected boreholes sunked in the southern part of Mesopotamian plain in order to shed light on the sedimentary environments during the Holocene period.

Mesopotamian plain sediments:

The sediments of this plain are related to the Quaternary period. These sediments are of economic value, which are the source of gravels, sands and clays used in constructions [4]. The sediments are friable with ranging between total thickness of these sediments is from 150 to 200 meters [5]. Multisource of sediments have been identified; fluvial, deltaic and marine and interfingering laterally and vertically[6]. The fluvial sediments composed of sand, silt and clay where the silt fraction percentage is the dominant [7]. These sediments originated from Tigris and Euphrates Rivers, and they contain gypsum grains and carbonates [8].

The deltaic sediments reveal the narrow spread distribution, and are restricted in the deltaic places of Tigris and Euphrates Rivers in the marsh area dominated by silt fraction [4]. These deltas have been constructed during sea-level fluctuations and climatic changes[9].

The recent marine sediments have been observed near Omara, and southwest of Nasiriyah[10, 11] which called Hammar Formation [12, 13]. This formation contains marine fauna(mollusca)[14] at different depths from 1 to 11 meters below water level of Tigris River at Omara and 12 meters below sea-Level at Basrah city [11, 15]. Bellen et al. [12]

stated that the formation composed of two parts; the lower part (14 feet in thickness) contains coarse sand grains with few percentage of silt fraction, whereas, the upper part (7 feet in thickness) represents a gray clay with shells. Hammar Formation was found beneath the recent fluvial sediments at marsh area [8], and the depth of this formation is from 7 to 14 meters and the thickness reaches a 20 meters at Zubair oil-field [5, 14]. The sedimentary environment of this formation is suugested to be a brackish- marine environment[16].

The basin of Mesopotamian plain has a long and complex tectonic history accompanied with the tectonic activities of the middle- east. The evidence of this tectonic continuity is the presence of the marsh area; even the continuous deposition of transported sediments by Tigris and Euphrates Rivers in this area[10].

Methods:

Three boreholes distributed around Basrah City have been selected (Fig. 1). Sedimentological and lithological characteristics were discussed in details in Al-Baidhany et al.[17]. Sixty- eight samples were chosen for fossil identification. Fifty grams were taken from each original sample, and living with distilled water and dispersed material (Sodium hexametaphosphate) for three days, then heating and stirring the samples. After heating, the samples were washed through a 63 μm mesh. Faunal contents separated by picking from terrigenous fraction comprise mostly mollusks, foraminifera and few ostracoda. Faunal species were identified in each sample and their abundance was determined by counting after preparing slides for binocular microscope.

Results:

The results of faunal identification and counting comprises foraminifera, mollusks and ostracoda of the three boreholes are indicated in Table-1. The main observed groups are:

Foraminifera group:
Ammonia beccaria (Linne')
Buccella frigida (Cushman)
Buccella sp.
Elphidium sp.
Miliammina fusca (Brady)
Nonion sp.
Qinqueloculina impressa (Parr)
Qinqueloculina seminulum (Linne')
Qinqueloculina sp.
Spiroloculina sp.

Mollusca group (Gastropoda):
Ancilla sp.
Anachis (Zafra) melatoma (Mevil and Standen)
Mangelia sp.
Odostomia sp.
Turitella sp.
Viviparus bengalensis
Vivipars sp.

Mollusca group(Pelecypoda):
Abra sp.
Corbicula fluminalis (Muller)
Corbicula consobrina (Caillaud)
Corbula sp.
Macoma sp.
Mactra sp.
Tellina sp.
Plcuna sp.
Yoldia sp.

Ostracoda group:
Cyprideis cf. torosa (Jones)
Cyprideis sp.

Table – 1. Assemblages of fossils.

Borehole No.	Depth/m	Foraminifera	Molluscs	Ostracods
1	0-6	++++	++	+++
	8-8.5	+++	+++	--
	9-14	---	---	---
	16-16.5	++++	++	+
	17-22	-	-	-
	24-27	---	---	---
2	0-4	++	---	---
	4-4.5	++++	---	---
	7-13	+	---	---
	15-30	---	---	---
3	0-13.6	+	+	--
	13.6-14.4	+	+	--
	14.4-28	---	---	---

\+ Very small amount
++ Small amount
+++ Abundant
++++ High amount
\- Appearance and absence
-- Absence
--- Completely absence

Discussion:

On the basis of the abundance and types of fossils, two biofacies and one lithofacies have been identified in this study;

Biofacies A: which is identified in borehole No. 1 (Fig. 2). This biofacies extends from ground surface to 9 meter in depth. It is characterized by the notable presence of foraminifera, and mollusks with abundant to absent ostracodes with depth (table-1). The present species of foraminifera are; Ammonia beccaria, Elphidium sp., Qinqueloculina samialuni, Q. sp., Buccella sp., Nonian sp., Miliammina fusca, Q. impressa, Spiroloculina sp. and Buccela frigida. The major part of these species is marine, especially Qinqueloculina sp., Spiroloculina sp. and Buccella sp. [18,19]. Whereas, the Ammonia beccaria and Elphidium sp. characterize a brackish environment [9, 20]. Moreover, the two species Nonion sp. and Miliammina fusca are related to brackish environment. Watikus [21] and Adams and Hayms [22] stated that the Ammonia beccaria and Buccella frigida signify an estuarine environment affected by marine water. Thus, it may be concluded that this biofacies reflects a marine or brackish water environment affected by short -term transgression period. Aqrawi [9] proved that sea fluctuated shortly during this period in that region. So, this biofacies could be represent short-term transgression period or it could be affected by marine water. The mollusks are rare in this biofacies, and they appear in depth between 3 and 4 meters only and the appeared species are Corbicula fluminalis, Tellina sp. and Plcuna sp. According to Macfadyen and vita Finzi [15], these species represent a fresh water environment. The rare appearance of mollusks species in this facies could permit to interpret that these species have been transported from other neighbor fresh water environment by fluvial system. The ostracodes are by Cyprideis sp. and Cyprideis torosa. This species belong to a brackish environment [19, 20].

Thin layer between 8 and 8.5 meter in depth is rich in foraminifera and mollusks and poor in ostracoda. The foraminifera species are Ammonia beccari and Elphidium sp., whereas, the molluscs species are Vivipars sp. and Viviparus bengalensis. Foraminifera and molluscs

species indicate a brackish and fresh water environments respectively. This thin layer could be attributed to a short- term regression period in this area.

Biofacies B: this biofacies distinguished in the three boreholes. In borehole no. 1 is between 9 and 22 meters in depth, whereas, in borehole no. 2 and 3, it is present as a top layer between ground surface and 14 meters. The biofacies B characterized by rare presence and/or disappearance of fossil assemblages except a thin layer in borehole no. 1 in depth between 16 and 16.5 meter. The disappearance of fossils or rare presence could be related to the isolation of this region and formation of lakes, no circulation occurred in water. This has been indicated by a pyritization in the present shells. The pyritization process proves a high reducing conditions and contemporaneous with the deposition of shells. ***Lithofacies C***: it is observed at depth more than 22m in borehole no. 1 and 14 to 30m. in boreholes no. 2, and 3 respectively. In this biofacies the life is completely absent, and there is no traces of assemblages. This could a complete isolation of the region and manifest a high intensity of evaporation, where the later is marked in the log by the presence of salt and gypsum crystals. Another suggestion could be proposed which is related to the tectonic setting of this area, as well as the aridity of the paleoclimate.The vertical and lateral variations in the faunal assemblages inferred this area to be more complicated, and retreat a reasonable conclusion for this case is not simple. So, it is thought to incline to the tectonism, which could be a mystery tool to resolve this problem. The suggestion supposes that there was a local subsidence caused the water table to be near the surface. The high rate of evaporation account for the formation of disseminated gypsum crystals in the stratigraphic column. According to the faunal assemblage distribution along these three boreholes, biofacies correlation could reveal that the study area was subject to a tectonic framework (Fig.2). Unfortunately, no carbon dating was done on these core samples to know the age of each biofacies. But, it could envision the scenario of the succession. During the deposition of the ancient lithofacies C, a relative short-term (in amplitude) subsidence could influence on the area. Consequently the water table approached to surface, followed by evaporation of saline water and forming gypsum grains. The region could highly resemble the playa. Followed by long-term subsidence to accommodate deposition of biofacies B sediments, at this time the region was transformed to isolated lake, marked by the presence of pyrite and pyritization of fossils. Interrupted by favorable periods of water circulation especially toward the south (borehole no. 1). Finally, the deposition of last biofacies A at the top of borehole no. 1 occurred during a short-term of transgression or opening to the sea, which let the region to be affected by marine water.

The geographic situation of borehole no. 1 is relatively approachable sea. So, this is a real complication in the stratigraphic succession for narrow aerial distribution in this region. Moreover, the study area is limited between two fresh water resources; Shatt Al-Arab River and the ancient channel of the Euphrates River [23], and near southern limits of the marsh region (Al-Hammar Lake). Then, these fresh water resources create a wide range of variation in biofacies. As it is stated above, unfortunately no carbon dating has been prepared to delineate the geologic history against this problem.

The surface layer between the ground surface and 8.5-9 meter in depth could be considered as ***Foraminifera – Molluscs datum***. It is widely distributed in this area, also Al-Jiboury [16] found this layer near Omara and Nasiriyah regions. Retaining to the age determination by Aqrawi [9], the relative age of this datum could be 3000 y B.P.

Conclusion:

The diversity in faunal assemblage observed in the recent sediments understudy infers the complication in the faunal living conditions. The occurrences of both fresh and marine faunal assemblage in the prevailed samples elucidate the effect of neighboring marine and fresh water environments in contribution of their faunal assemblage to the study area. The low tectonic activity accompanied by sea ward retreat of shore line caused the isolation of many coastal basins, these basins were evolved under arid paleoclimate causing the evolution of anoxinic environment and the deposition of gypsum grains within the evaporates lithofacies.

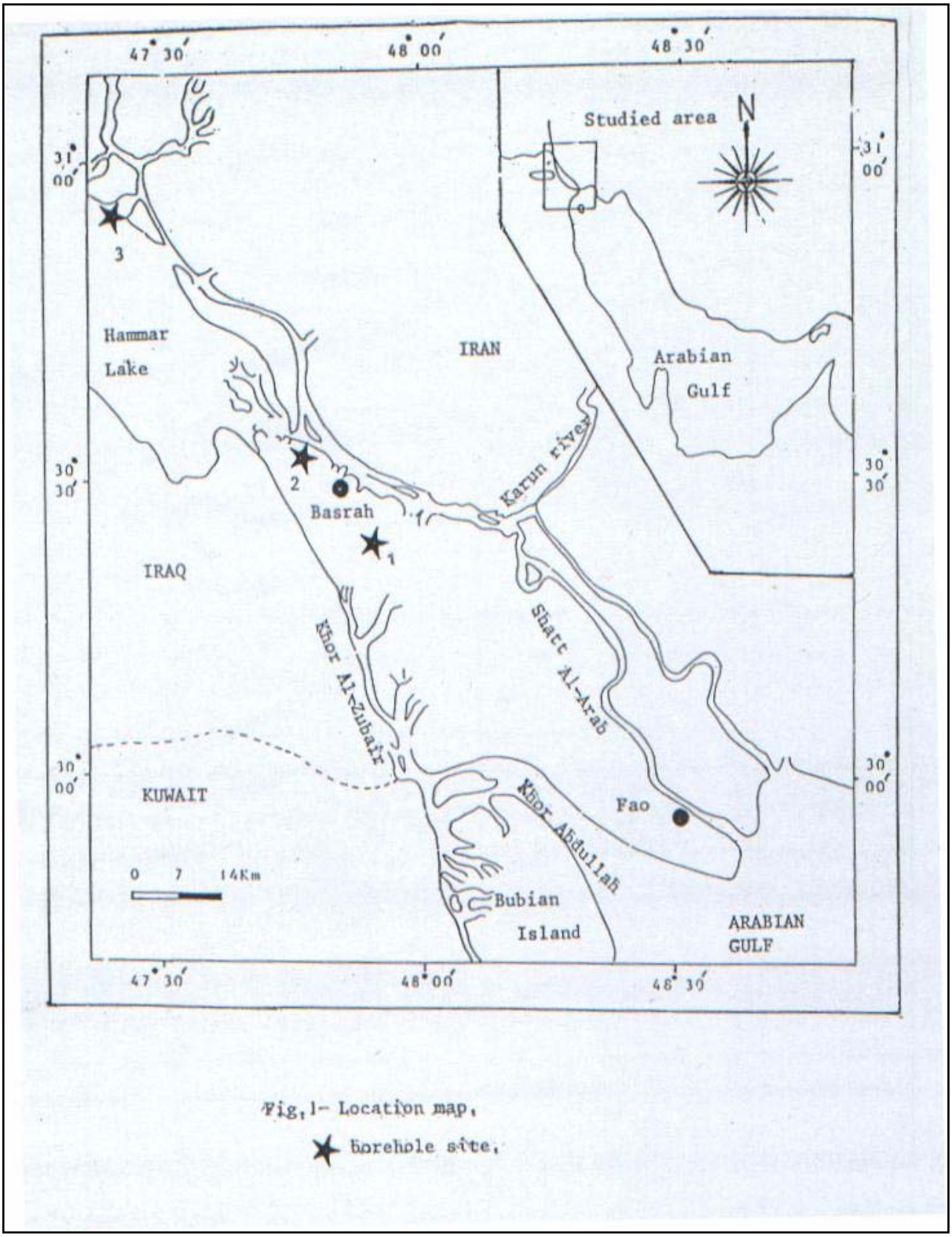

Fig. 1- Location map,
★ borehole site.

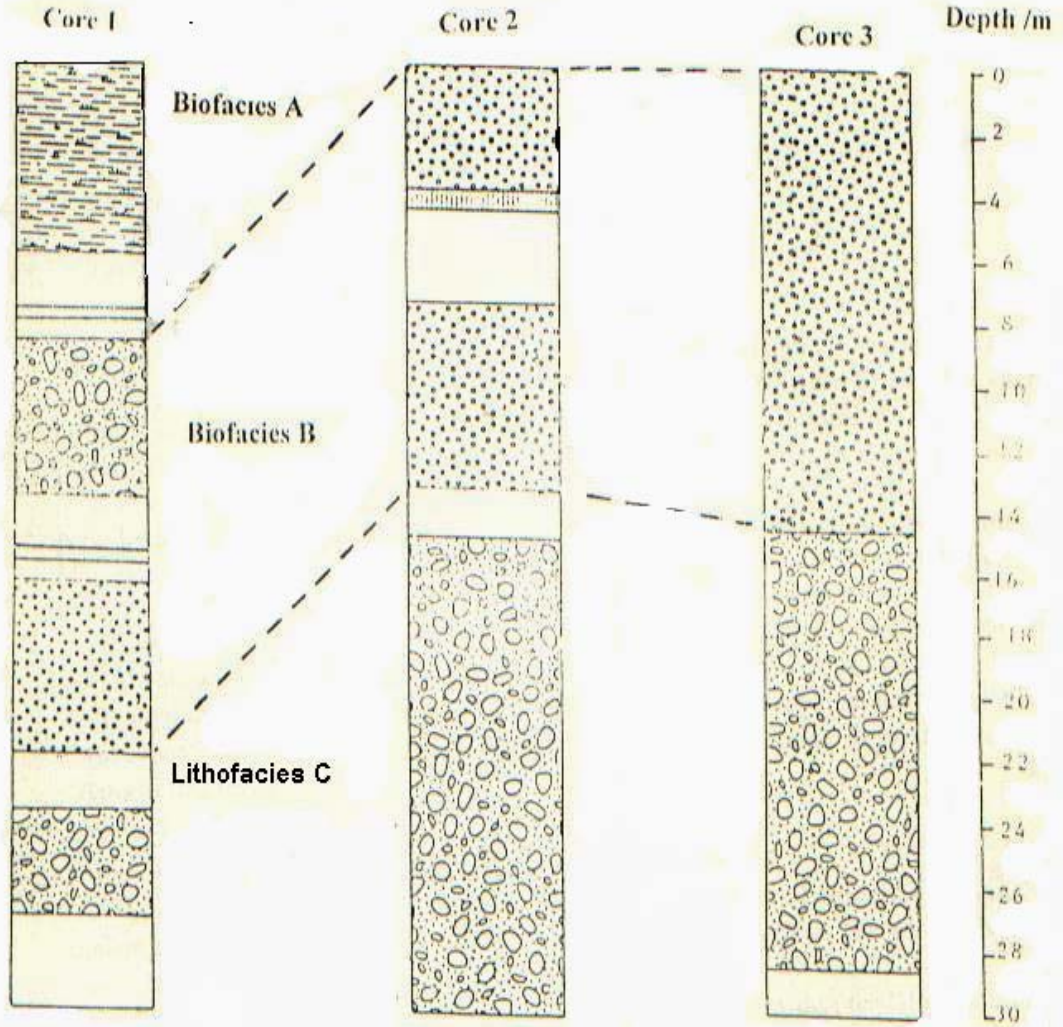

Fig. 2- Log of biofacies.
(Lithological description in Al-Baidhany et al., 2002).

References:

[1] Bernasconi, M.P. and Stanley, D.J., Molluscan biofacies and their environmental implicatery, Nile delta lagoon, Egypt. J. Coast. Res.,v.10,no.2,pp.440-465. 1994.
[2] Woodroffe, C.D., Murray, W.C.V., Bryant, E.A., Brooke,B., Heijnis, H. and Price, D.M., Late Quaternary sea-level highstands in the Tasmania sea: evidence from Lord Howe Island. Mar. Geol., v.125, no.1-2,pp. 61-72. 1995.
[3] Aqrawi, A.A.M., and Evans, G.,. Sedimentation in the lakes and marshes (Ahwar) of the Tigris – Euphrates Delta, southern Mesopotamia. Sedimentology, v.41, pp. 755-776. 1994.
[4] Salman, H.H., Some Sedimentological and mineralogical characters of Shatt Al-Arab estuary levee sediments. Mar. Sci. Centre, Tech. report, No.8,16p. 1982.
[5] Buday, T., Stratigraphy and paleogeography, In: Kassab, I.I.M. and Jassim, S.Z. (Eds.) The regional geology of Iraq. V.1, Mosul Univ. press, 445p. 1980.
[6] Parsons, R.M., Ground-water Resources of Iraq, vol 11; Mesopotamian plain. Ministry of Development Board, Baghdad, 157p. 1957.
[7] Buringh, P., Soils and soil conditions of Iraq. Ministry of Agriculture-D.G. Agric. Res. And Project, Baghdad, 322p. 1960.
[8] Abdullah, M.B., Sedimentology, petrography, geochemistry and hydrochemistry of the recent sediments of Hor Al-Hamar in southern Iraq. Unpubl. MSc. Thesis, Univ. of Baghdad(In Arabic). 1982.
[9] Aqrawi, A.A.M., Implication of sea level fluctuation, sediment and neotectonics for the evolution of the marsh lands (Ahwar) of southern Mesopotamia. Quaternary Proceedings no.3, Quaternary Research Association, Cambridge, pp.21-31. 1993.
[10] Lees, G.M. and Falcon, N.L., The geographical history of the Mesopotamian plain. Geographical J., v.118, pp.24-39. 1952.
[11] Hudson, R.G.S., Emes,F.E. and Wilkins, G.L., The fauna of some recent marine deposits near Basrah, Iraq. Geol. Magazine, v.94,pp.393-401. 1957.
[12] Van Bellen, R.C., Dunnington, H.V., Wetzel, R. and Morton, D.M., Lexique stratigraphique inter. Asia., Fasc. 10a, Iraq. Center Nat. Resh. Sci., Paris, 333p. 1959
[13] Dance, S.P. and Eames, F.E., New molluscs species from the Recent Hammar Formation of S.E. Iraq. Geol. Mag., 94,pp.393-401. 1966.
[14] Al-Naqib, K.M., 1967. Geology of Arabian Peninsula, south western Iraq. US.G.S., prof. Paper, 560G, 54p. 1967. [15] Macfadyen, W.A. and Vita-Finzi, C., Mesopotamia. The Tigris-Euphrates delta and its Holocene Hammar fauna. Geol. Mag., v.115, pp.287-300. 1978.
[16] Al-Jibouri, B.M., Paleontology indeces of climate and environmental changes during Quaternary period of Mesopotamian plain, south Iraq. Unpubl. MSc. Thesis, Univ. of Baghdad (In Arabic). 1997.
[17] Al-Baidhany, A., Darmoian, S. and Albadran, B., Evaluation of Holocene sedimentary environments of the southern part of Iraq. Basrah J. of Science, v.20(1), pp. 73-86. 2002.
[18] Murray, J.W., British near shore foraminiferids. Synopsis of the British fauna, New series, no.16, pp.1-68. 1979.
[19] Salman, B., Re-interpretation of the ecology of the Hammar Formation from subsurface section in Amarah-Basrah area, Iraq. GEOSURV. Lib. Unpubl. Rep., no.2058, 23p. 1993.
[20] Murray, J.W., Ecology and palaeoecology of benthic foraminifera. Longman Scientific and Technical, New York. 1991.
[21] Watkins, S.G., Foraminifera ecology around the Orang Country, Califorinia, ocean sewer outflat. Micropaleontology, v.7, no.2, pp. 1961.
[22] Adams, T.D. and Haynes, J., Foraminifera in Holocene marsh cycle at Borth Curdigan Shire. Wales paleontology, v.8, no.1,pp.27-28. 1965. [23] Al-Sakini, J.A., New look on the history of old Tigris and Euphrates Rivers, in the light of

geological evidence, recent archeological discoveries and historical sources. Oil exploration company-Baghdad-Iraq (In Arabic). 1993.

السحنات الحياتية والبيئات الرسوبية للرواسب الحديثة في الجزء الجنوبي من وادي الرافدين

عباس حميد البيضاني و بدر نعمة البدران

فزل علىءالآنص / تكي بطكعكل

جئلع بطكا شنب

طلازةخكش

اختيرت ثلاثة أبار موزعة حول مدينة البصرة في الجزء الجنوبي من سهل وادي الرافدين. تراوحت أعماق هذه الآبار بين 27 و 30 مترا". اعتمادا" على التجمعات الحياتية، تم تمييز سحنتين حياتيتين وواحدة صخارية: من الأعلى والى الأسفل، السحنة الحياتية A والتي تمثل السحنة السطحية في النهايات الجنوبية من وادي الرافدين. من المحتمل أن تمثل هذه السحنة فترة طغيان بحري موقعي. تحتها توجد السحنة الحياتية الثانية B والتي تغطي الجزء الجنوبي من وادي الرافدين. من الممكن أن تظهر هذه السحنة فترة هبوط تكتوني والذي أدى إلى عزل وتكوين بيئة مختزلة مصحوبة بعملية تكون البايرايت. السحنة الصخارية C والتي تقع تحت السحنة الحياتية الثانية، وظهرت في الجزء الجنوبي من وادي الرافدين، وكانت الأحياء مفقودة تماما" وظهرت هناك حبيبات جبسية والتي تعني بأن التبخير كان عالي. أن التوزيع العمودي والأفقي لهذه السحن يمكن أن يعزى إلى الأحداث التكتونية في المنطقة.