*Mesopot. J. Mar. Sci., 2010, 25 (2): 176 - 187*

# Sedimentological and environmental aspects of subsurface Basrah sediments-south Iraq

**M.H.A. Al-Jabberi**

*College of Science, Basrah University, Basrah - Iraq*
*e-mail: Jaberi76@yahoo.com*

*(Received: 25 March 2009 - Accepted: 30 March 2010)*

**Abstract -** Twelve core samples were collected from 8, 10, 15, 21, 24.5 and 30 m depth from two holes in Basrah city. Textural analysis showed that the sediments of the first hole (Al-Ashar area) were siltyclay in nature at depth 8m , followed by clayeysilt at 10-21m (Saad square), whereas sand sediments were found at depths 24.5 to 30m. The statistical parameters of grain size analysis of the sediments of each hole indicated that the sediments at depth 8-21m were deposited under low energy environment. On the other hand the sediments at depth 24.5-30m were deposited under high-energy environments. The identified heavy minerals in the present study could be categorized into four groups; mica group, un-stable, ultra stable and meta-stable group minerals.

**Keywords**: Saad square, Basrah, Ashar, subsurface sediment.

## Introduction

The Mesopotamian plain is mostly covered by sediments of the Quaternary period which consist largely of silt and clay with little amount of sand (Buringh, 1960). Most of these sediments had been transported by fluvial activity of Tigris and Euphrates rivers. Furthermore, the Mesopotamian plain sediments are characterized by a lateral change into litho facies. The topography of Basrah city surface in general is flat and simple (Darmoian and Lindqvist, 1988).

The ground water level is near to the surface and flow south and south east towards the Arabian Gulf (Al-Khiat, 2002). Basrah is located within un-stable shelf in Zubair subzone (Buday and Jassim, 1987). According to Kareem (1991) Basrah has six geomorphologic units: River levees, estuarine river levees, silted tidal flats, tidal flats, marshes, swamp deposits and sand dunes.

Studies dealt with the Quaternary sediments in Basrah city are available, such as Salman and Al-Musawy (1994) who found that most of the sediments at depth 1m-18.5m were clayeysilt with very little percentage of sand while the sediments at depth 21m-24m were sandysilt and sand, respectively. Khan *et al.* (1992) found that the subsurface sediments from the surface down to 21m were soft to stiff clay while the sediments from 21-30m were sand.

The present study aimed to delineate the sedimentological characters of Basrah sediments in order to recognize the factor of depositional environment.

## Methodology

Twelve core samples were collected from two bore holes at different depth intervals (8m, 10m, 15m, 21m, 24.5m and 30m) were sent to the Center of National Laboratories for analysis (Figure 1). Wet sieving was used to separate the sand from the mud by using a sieve of 230 mesh (Folk, 1974). Hydrometer method was used to determine the grain texture. The heavy minerals were separated by using Bromoform solution and the minerals were identified by polarized microscope.

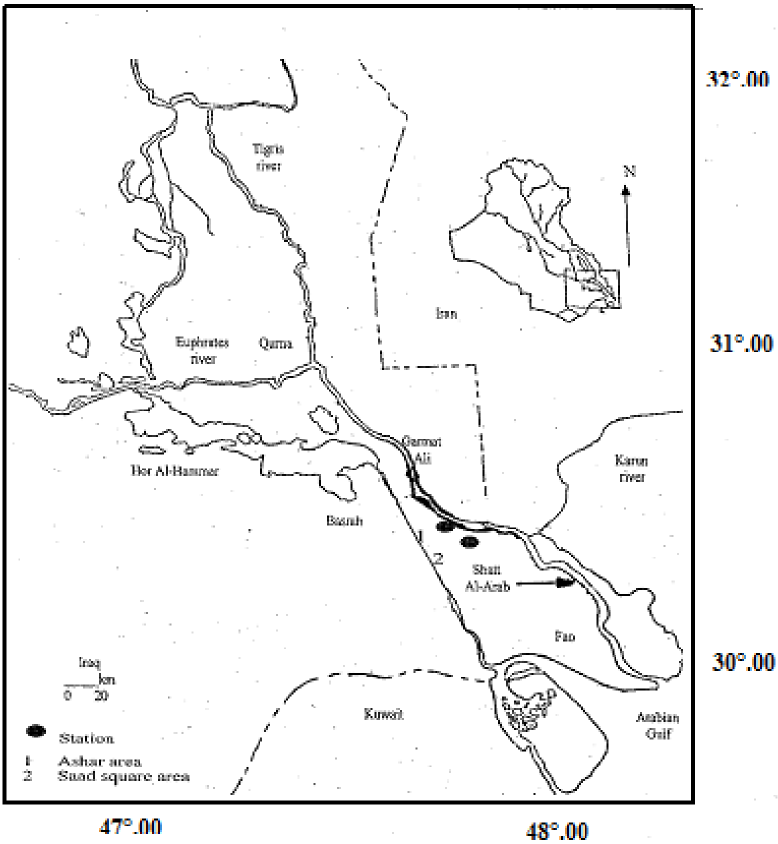


Figure 1. Map showing Basrah city and sampling sites.

## Results and Discussion

The sedimentological analysis of the first hole (Figure 2) showed that the sediments at 8m depth were soft siltyclay grey in colour with 50% clay, 46% silt and 4% sand (Table 1), whereas the sediments at 10m depth were soft to stiff clayey silt grey to green in colour having 41% clay, 55% silt and 4% sand. The sediments at 15 m depth were stiff clayey silt with grey to

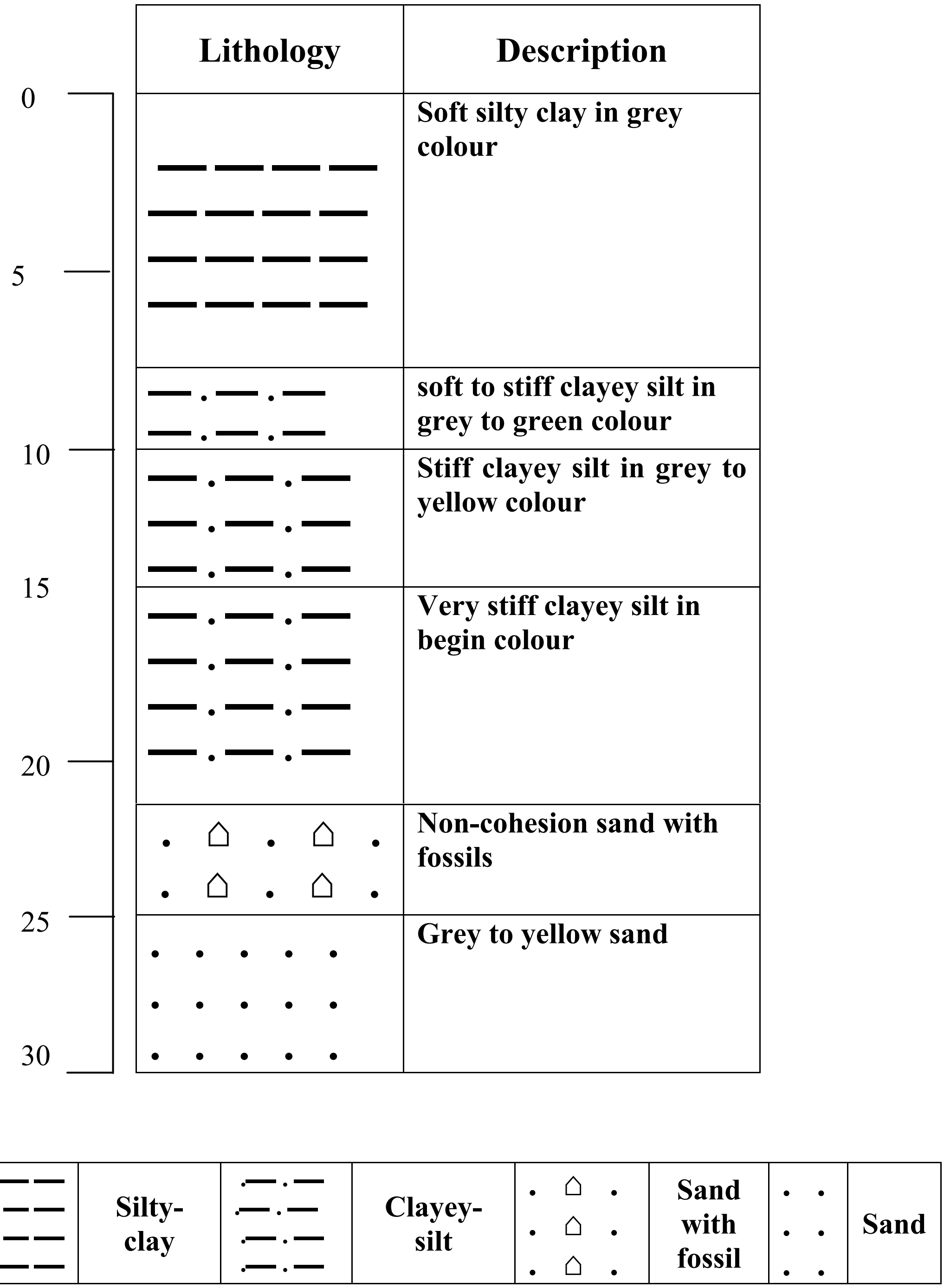


Figure 2. Lithological description of Al-Ashar area.

yellow colour having 38% clay, 56% silt and 6% sand. The sediments at 21m depth were clayey silt, beige in colour with 34% clay, 60% silt and 6% sand, whereas the sediments at 24.5m depth were non –cohesion sand sediments with high percentage of shell fragments and fossils with some clastic sediments may reach a coarse size in pebbles size and consist of 9% clay, 18% silt and 73% sand. The sediments at 30m depth were very fine sand grey to yellow in colour having 10% clay, 15% silt and 75% sand.

Table 1. Grain size analysis and statistical parameters of sediments of the first hole (Al-Ashar area).

| *Depth NO.* | *Sand %* | *Silt %* | *Clay %* | *Texture* | *Mean size Ø* | *Median Ø* | *Sorting Ø* | *Kurtosis Ø* | *Skewness Ø* |
|---|---|---|---|---|---|---|---|---|---|
| 8 m | 4 | 46 | 50 | Silty-Clay | 8 | 8 | 3 | 0.71 | 0.1 |
| 10 m | 4 | 55 | 41 | Clayey-Silt | 7 | 7 | 2 | 0.95 | 0.2 |
| 15 m | 6 | 56 | 38 | Clayey-Silt | 7 | 7 | 2 | 0.90 | 0.25 |
| 21 m | 6 | 60 | 34 | Clayey-Silt | 7 | 6 | 2 | 0.91 | 0.13 |
| 24.5 m | 73 | 18 | 9 | Sand | 1 | 2 | 0.3 | 1.5 | -0.13 |
| 30 m | 75 | 15 | 10 | Sand | 2 | 2 | 0.4 | 2 | -0.3 |

The heavy minerals of the sediments (Table 2) showed that Chlorite, Pyroxene, Garnet and Hornblende minerals are the dominate heavy minerals at 8m, which indicates that basic, ultra-basic igneous rocks and metamorphic rocks are the main source rocks (Gaezanti *et al.*, 1998), and the Chlorite, Zircon, Hornblende, Basaltic Hornblende and Pyroxene minerals were the most heavy minerals of the sediments at 10m which reflect that basic, ultra-basic igneous rocks and old sedimentary rocks form the dominate source rocks (Philip, 1968), while the heavy minerals in the sediment at 15m depth were Chlorite, Biotite, Opaque minerals, Pyroxene and Hornblende, indicating the basic and ultra-basic igneous rocks are the dominant source of rocks (Al-joboury, 2002). The heavy minerals in the sediment at 21m depth were Chlorite, Hornblende, Garnet, Pyroxene and Epidote and these showed that basic, ultra-basic igneous rocks and metamorphic rocks are the dominant source rocks (Philip, 1968). The Chlorite, Tourmaline, Zircon, Biotite and Pyroxene were the main heavy minerals at 24.5m, indicating that the basic, ultra-basic igneous rocks and old sedimentary rocks. The Hornblende, Pyroxene, Garnet, Zircon and Opaque minerals represented the heaviest minerals at 30m depth, and these proved the basic, ultra-basic igneous rocks and old sedimentary rocks are the major source of rocks.

Table 2. Heavy minerals in sediments of the first hole (Al-Ashar area).

| | Depth 8m | Depth 10m | Depth 15m | Depth 21m | Depth 24.5m | Depth 30m |
|---|---|---|---|---|---|---|
| Heavy minerals | Chlorite | Chlorite | Chlorite | Chlorite | Chlorite | Hornblende |
| | Pyroxene | Zircon | Biotite | Hornblende | Tourmaline | Pyroxene |
| | Garnet | Hornblende | Opaque M | Garnet | Zircon | Garnet |
| | Hornblende | Basaltic H | Pyroxene | Pyroxene | Biotite | Zircon |
| | Kayanite | Pyroxene | Hornblende | Epidote | Pyroxene | Opaque M |
| | Epidote | Garnet | Garnet | Zircon | Hornblende | Chlorite |
| | Opaque M | Biotite | Basaltic H | Opaque M | Basaltic H | Biotite |
| | Zircon | Kyanite | Cellestite | Tourmaline | Garnet | Tourmaline |
| | | Epidote | Zircon | Cellestite | Opaque M | Cellestite |
| | | Staurollite | Tourmaline | Staurollite | | |
| | | Cellestite | | | | |

M: Minerals, H: Hornblende

The grain size analysis of the second hole sediments (Saad Square) (Table 3) showed that the sediments at 8m depth were soft Clayey silt, green to grey in colour (Figure 4), which consist of 31% clay, 66% silt and 3% sand. The sediments at 10m depth were soft to stiff clayey silt yellow to green in colour and these sediments consist of 40% clay, 55% silt and 5% sand, while the sediments at 15m depth were stiff clayeysilt grey in colour and contain 34% clay, 62% silt and 4% sand. The sediments at 21m depth

Table3. Grain size analysis and statistical parameters of sediments of the second hole (Saad square).

| *Depth NO.* | *Sand %* | *Silt %* | *Clay %* | *Texture* | *Mean size Ø* | *Median Ø* | *Sorting Ø* | *Kurtosis Ø* | *Skewness Ø* |
|---|---|---|---|---|---|---|---|---|---|
| 8 m | 3 | 66 | 31 | Clayey silt | 7 | 8 | 3 | 0.91 | 0.21 |
| 10 m | 5 | 55 | 40 | Clayey silt | 7 | 7 | 3 | 0.92 | 0.17 |
| 15 m | 4 | 62 | 34 | Clayey silt | 7 | 7 | 3 | 0.84 | 0.11 |
| 21 m | 10 | 50 | 40 | Clayey silt | 7 | 7 | 3 | 0.85 | 0.12 |
| 24.5 m | 79 | 10 | 11 | Sand | 2 | 2 | 0.31 | 2.3 | -0.23 |
| 30 m | 72 | 20 | 8 | Sand | 1 | 2 | 0.34 | 2 | -0.31 |

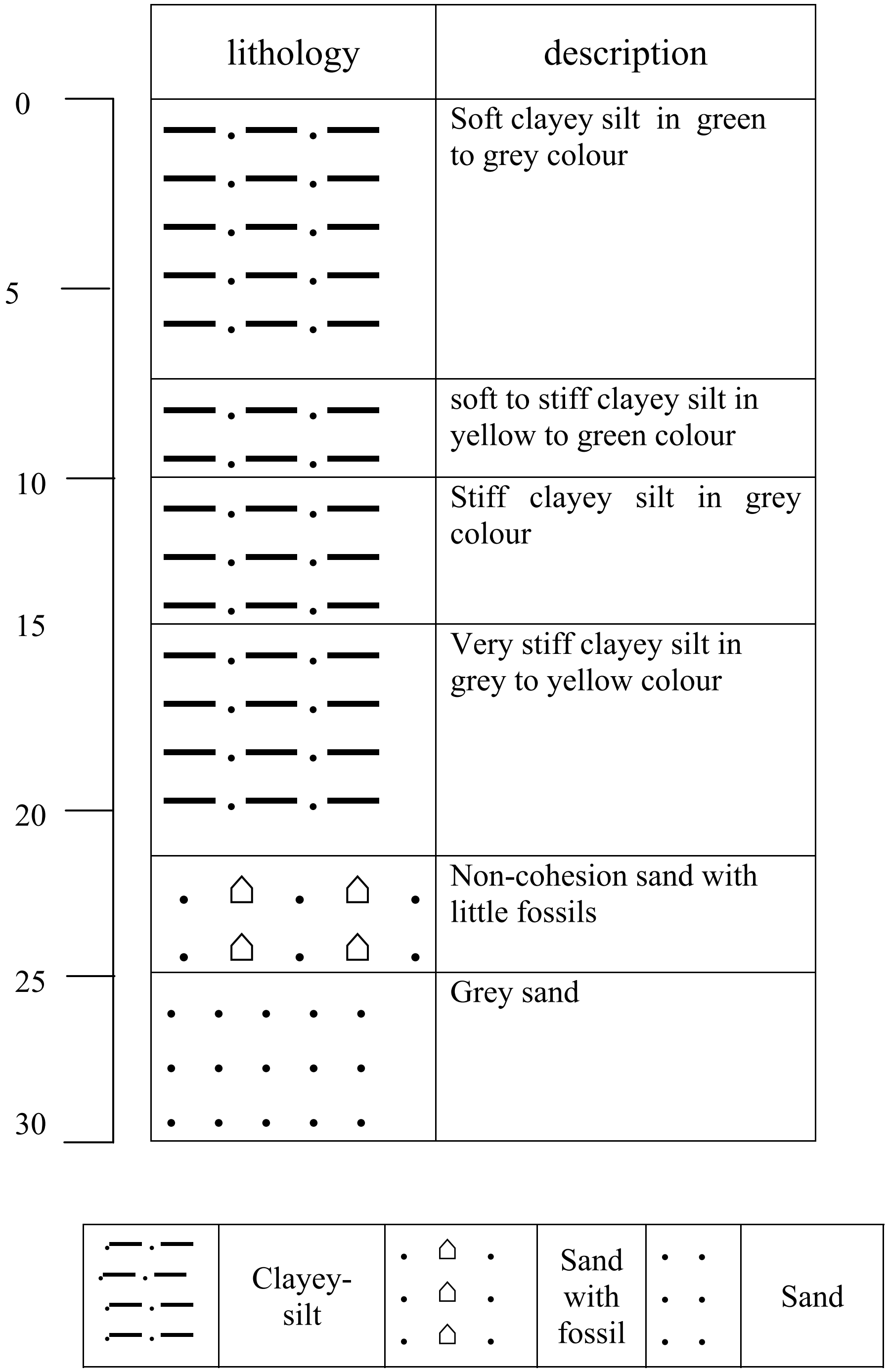


Figure 4. Lithological descriptionof Saad square sediment

were very stiff clayeysilt grey to yellow in colour with 40% clay, 50% silt and 10% sand, whereas the sediments at 24.5m depth were non-cohesion sand, grey in colour with very little share of fossils and shell fragments which differ from the sediments at the same depth from the first hole and the grain size analysis of these sediments showed that clay was 11%, 10% silt and 79% sand, while the sediments at 30m depth were grey sand sediments having 8% clay, 20% silt and 72% sand.

The heavy minerals analysis of the second hole (Table 4) showed that sediments at 8m contain Hornblende, Chlorite, Pyroxene and Biotite minerals, reflected the basic and ultra basic igneous rocks which are the main source rocks of these sediments. The Chlorite, Pyroxene, Zircon and Hornblende were the dominant heavy minerals at 10m depth originated from basic, ultra basic igneous rocks and old sedimentary rocks.

Table 4. Heavy minerals in sediment of the second hole (Saad square).

| Depth 8m | Depth 10m | Depth 15m | Depth 21m | Depth 24.5m | Depth 30m |
|---|---|---|---|---|---|
| Hornblende | Chlorite | Opaque M | Chlorite | Chlorite | Hornblende |
| Chlorite | Pyroxene | Chlorite | Zircon | Zircon | Zircon |
| Pyroxene | Zircon | Garnet | Hornblende | Tourmaline | Opaque M |
| Biotite | Hornblende | Hornblende | Opaque M | Pyroxene | Chlorite |
| Opaque M | Basaltic H | Basaltic H | Staurollite | Hornblende | Biotite |
| Garnet | Garnet | Biotite | Tourmaline | Garnet | Tourmaline |
| Kyanite | Cellestite | Epidote | Garnet | Basaltic H | Cellestite |
| Zircon | Epidote | | | Opaque M | |
| | Staurollite | | | | |

M: Minerals, H: Hornblende

The opaque minerals, Chlorite, Garnet and Hornblende were the majority of heavy minerals at 15m and these indicated that basic, ultra basic igneous rocks and metamorphic rocks were the main source rocks of these sediments, whereas the heavy minerals at 21m depth were Chlorite, Zircon, Hornblende and opaque minerals. The source of these minerals were basic, ultra basic igneous rocks and old sedimentary rocks. The Chlorite, Zircon, Tourmaline and Pyroxene are the majority heavy minerals at 24.5m, indicating that the basic, ultra basic igneous rocks and old sedimentary rocks are the main source rocks at this depth. The heavy minerals at 30m depth were Hornblende, Zircon, Opaque minerals and Chlorite, this emphasized that the basic, ultra basic igneous rocks and old sedimentary rocks were the main source rocks.

The statistical parameters of grain size analysis of each bore holes (Table 1 and 3) (Figures 3-A, B, C, D, E and F, and 5-A, B, C, D, E and F) showed that sediments at 8, 10, 15 and 21m depth were fine from silt and clay, very poorly sorted, fine positive skewed and meso to platy kurtic (Folk, 1974), and the sediments at 24.5 and 30m depth were sand sediments, very well sorted, negative coarse skewed and very lepto kurtic (Folk, 1974). Projection of the data of all depths on Stewart diagram (Figure 6) indicated that sediments at 8m, 10m, 15m and 21m of each bore hole representing quite water (low energy) while the sediments at 24.5m and 30m indicating beach environment (high sector energy).

This conclusion was supported by the fossils contents in clastic sediments at 24.5m depth, through the finding of some type of foraminifera represented by the group Rotaliina especially Ammonia and Elphidium. These types are clear indicator of shallow marine water with normal salinity (Ragi and Salman, 1983).

## Conclusion

1. The sediments of Basrah at 8m, 10m, 15m and 21m depth from each bore holes were siltyclay and clayeysilt with little percentage of sand whereas the sediments at 24.5m and 30m were sand sediments with some shells fragments and fossils.
2. The heavy minerals at 8, 10, 15 and 21m depth in the first hole were Chlorite, Pyroxene, Garnet and Hornblende with little percentage of Biotite, Kyanite, Staurollite, Zircon and Tourmaline, whereas the Chlorite, Biotite, Ultra-stable minerals, Hornblende and pyroxene were the dominant heavy minerals at 24.5m and 30m. The most heavy minerals at 8, 10, 15 and 21m in the second hole were Chlorite, Hornblende, Zircon and Opaque minerals while Chlorite, Ultra stable, Hornblende and Pyroxene were the dominant heavy minerals at 24.5 and 30m.
3. The statistical parameters of grain size analysis of each bore holes showed that the sediments at 8m, 10m, 15m and 21m formed at quite energy conditions while the sediments at 24.5m and 30m formed at high energy conditions (beach environment).
4. The source rocks of sediments of the first hole at 8, 10, 15 and 21m depth were basic and ultra-basic igneous and metamorphic rocks with little share of old sedimentary rocks while the source rocks of sediments at 24.5m and 30m depth were basic and ultra-basic igneous rocks and old sedimentary rocks. On the other hand, the source rocks of sediments at 8-30m in the second hole were basic and ultra-basic igneous rocks and old sedimentary rocks.

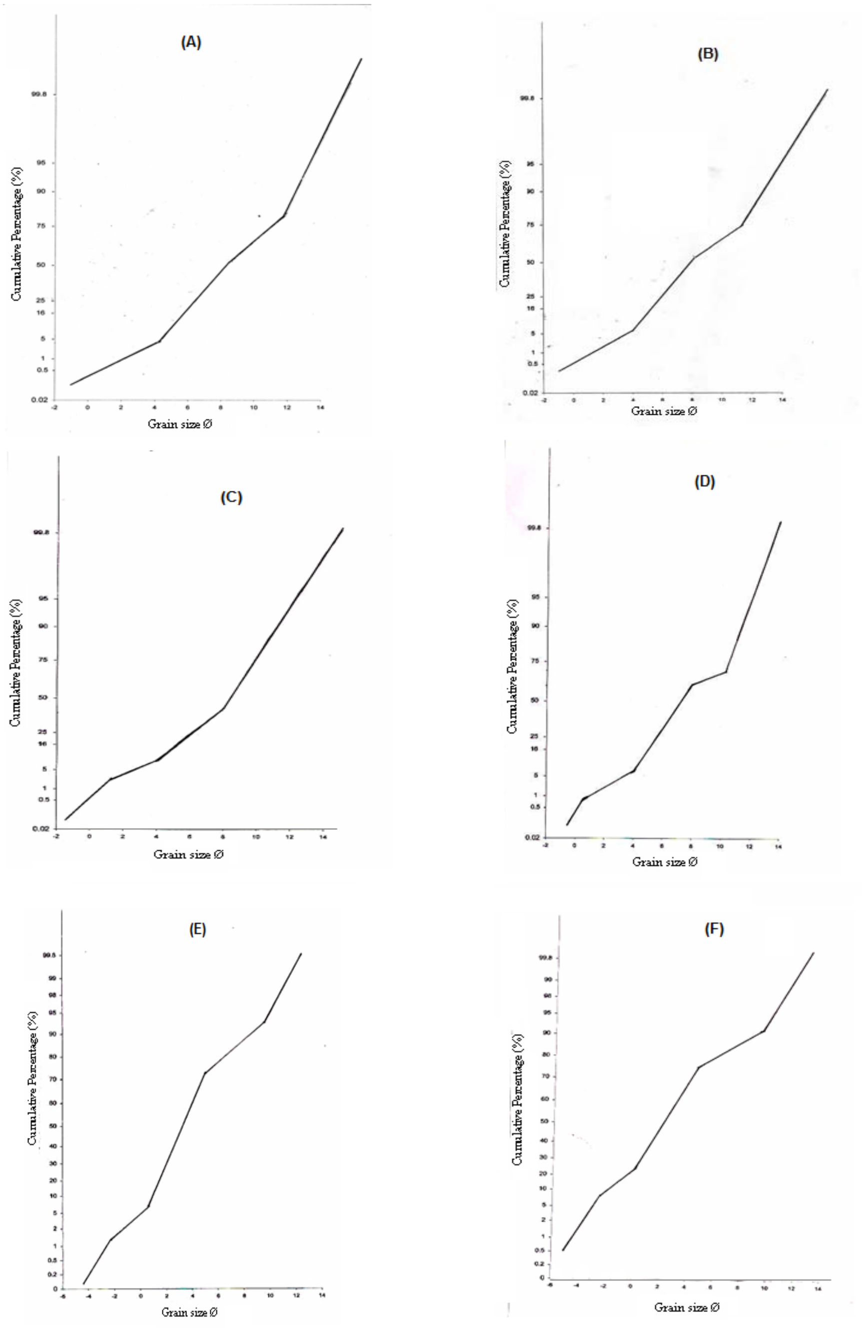


Figure 3. Cumulative curve of : A: 8 m, B: 10 m, C: 15 m, D: 21 m, E: 24.5 m and F: 30 m.

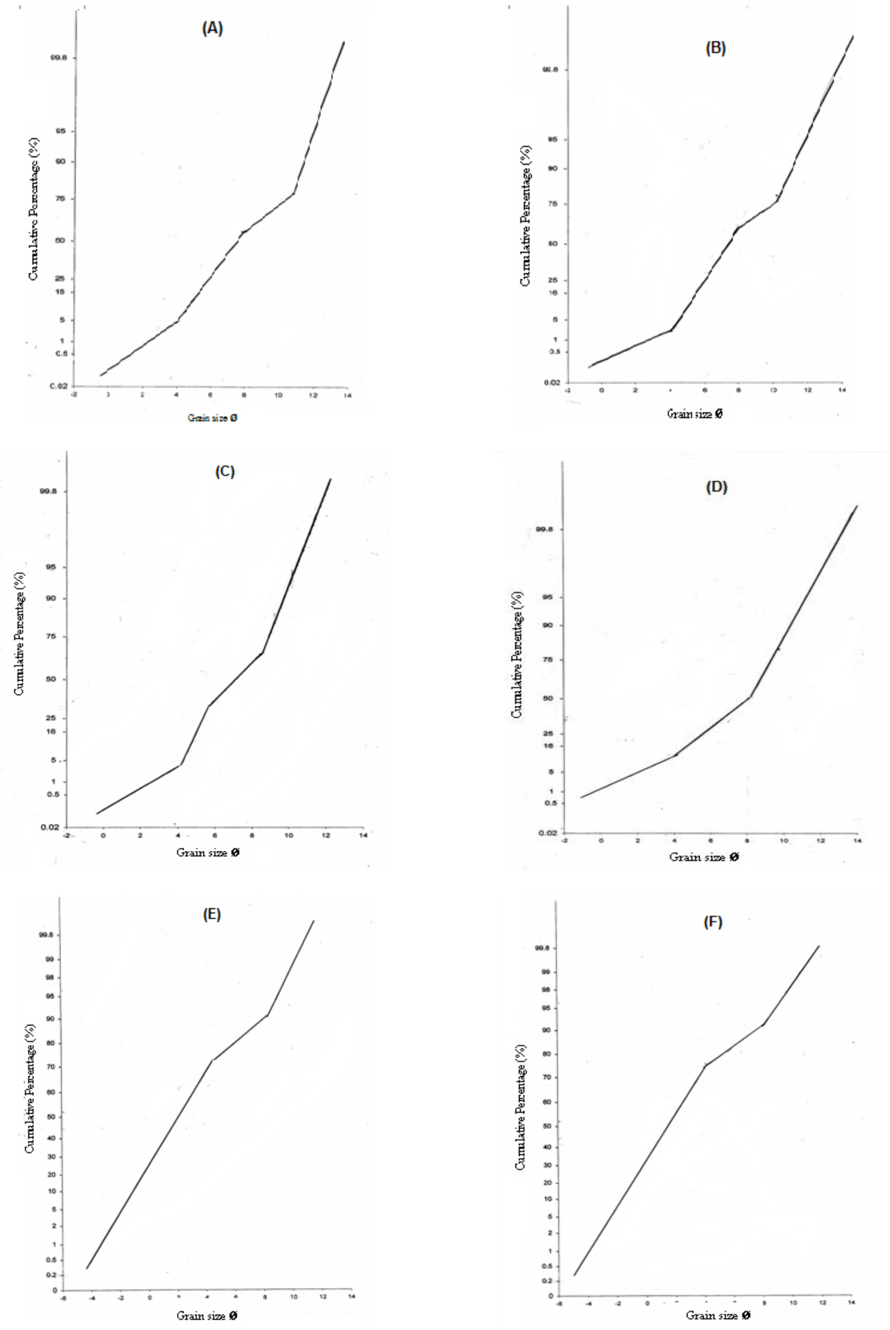


Figure 5. Cumulative curve of (A: 8 m, B: 10 m, C: 15 m, D: 21 m, E: 24.5 m and F: 30 m).

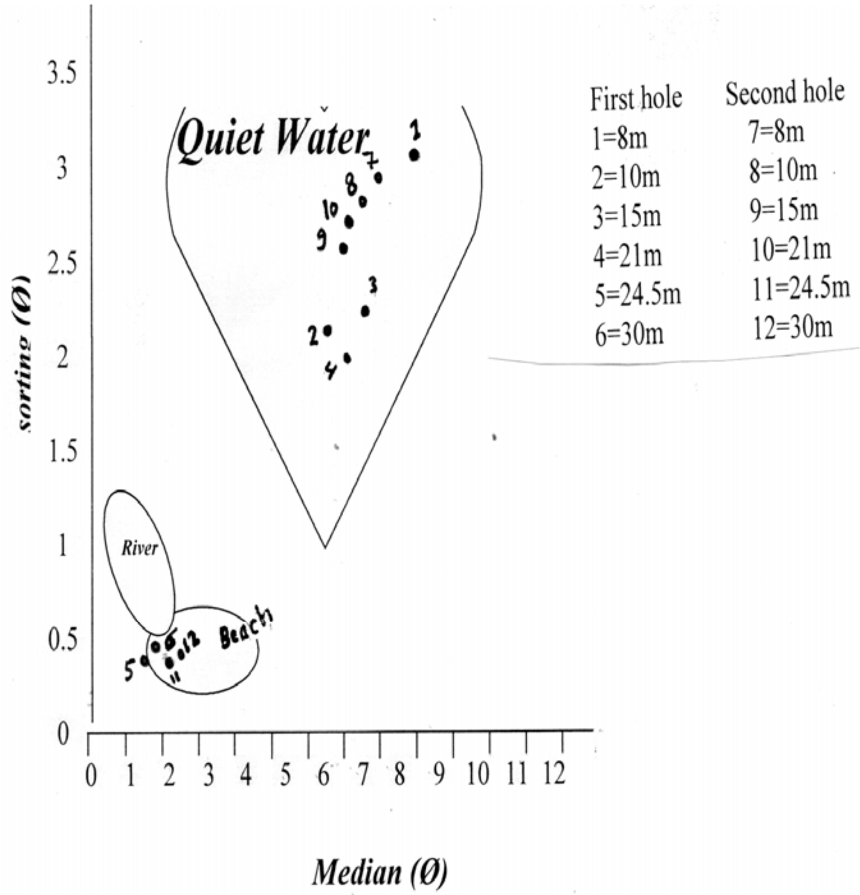


Figure 6. Position of different depth sediments at Stewart diagram (1958).

## References

Al-juboury, A.I. 2002. Mica enrichment in the recent sediments of Tigris river, N. of Iraq. Rafidain Jour. Science, Mosul Univ., 13(2): 90-98.

Al-Khaiat, N.N.M. 2002. Form of sabkha and Aeolian deposits west of shatt al-Arab rivers, A geomorphologic study. Unpublished Ph.D .thesis, Baghdad Univ., 272p. (in Arabic).

Budy, T. and Jassim, S. 1987. The regional geology of Iraq. (Techtonism Magmatism). D.G. of Geol. Surv. and Min Baghdad, Iraq, 322p.

Buringh , P. 1960. Soil and conditions of Iraq Ministry of Agriculture-D.G. Arg. C. Res. and project, Baghdad, 322p.

Darmoian, S.A. and Lindqvist, K. 1988. Sediments in the estuarine environment of the Tigris/Euphrates Delta; Iraq. Geological J., 23: 15-37.

Folk, R.l. 1974. Petrology of sedimentary Rocks; Henphill pub. co, Texas, 182p.

Gaezanti, E., Schtella, M. and Vidimari, C. 1998. Provenance from ophiolites and Oceanic allochatons: Modern Beach and river sands from Liguria and northern Appennines (Italy), 23: 65-82.

Karim, H.H. 1991. Structural nature of Lower Mesopotamian region from Geophysical Observations, Proceeding of third symposium, Ocean0graphy of Khor Al-Zubair, Basrah, Research, PP. 15-25.

Khan, N., Albadran, A.A. and Albadran, B. 1992. Some Engineering aspects of the alluvial deposits at Basrah region, S. Iraq. Geol. J., 25(1): 80-91.

Philip, G. 1968. Mineralogy of recent sediments of Tigris and Euphrates river and some older detrital deposits. Bull. Coll. Soc., 91: 159-173.

Raji, W. and Salman, B. 1983. Paleontological and environmental study of the mesopodmian plain in samawa-Nasiriya area .Geoserve. Lib.Unpub-Rep.NO.1321 Baghdad.

Salman, H. and Al-Mussawy, S. 1994. Some Sedimentological aspects of the Shatt Al-Arab levee Sediments. Iraqi Geological J., 27 (3): 20-39.

# دراسة للمواصفات الرسوبية و البيئية للرسوبيات تحت السطحية في محافظة البصرة، جنوب العراق

**مهند حامد عبود الجابري**

*كلية العلوم، جامعة البصرة، البصرة العراق*

**المستخلص -** جمعت أثنى عشر نموذجاً للرسوبيات تحت السطحية في محافظة البصرة وعلى أعماق8 و10 و15 و21 و24.5 و30 متر لبئرين في محافظة البصرة. بينت دراسة التحليل الحجمي الحبيبي لرسوبيات المنطقة قيد الدراسة للبئر الأول الواقع في منطقة العشار بأن رسوبيات أعماق 8 متر كانت رسوبيات طينية غرينية تتبعها رسوبيات غرينية طينية لأعماق 10 – 21 متر ورسوبيات رملية لأعماق 24.5 متر و30 متر. بينما كان نسيج الرسوبيات للمنطقة قيد الدراسة للبئر الثاني الواقع في منطقة ساحة سعد ولأعماق 8 – 21 متر غرينية طينية ورسوبيات رمليه لأعماق 24.5 متر و30 متر. دراسة المعاملات الحجمية الإحصائية بينت بان رسوبيات أعماق 8 -21 متر كانت قد ترسبت في بيئات واطئة الطاقة بينما رسوبيات أعماق 24.5 -30 متر قد ترسبت في بيئات عالية الطاقة. المعادن الثقيلة المشخصة يمكن أن نصنفها إلى أربعة مجاميع رئيسية وهي مجموعة المعادن الصفائحية، مجموعة المعادن غير المستقره، مجموعة المعادن فوق المستقرة ومجموعة المعادن شبه المستقرة.