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MINERALS VARIATION IN IRAQI MARINE SEDIMENTS

Geology

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ABSTRACT

Total of 32 samples that collected from seven marine core sediments in the north and Northwest of Arabian Gulf (between Umm Qasir port to Basrah Oil Port) (Figure 1) were investigated in this study . Silt and sandysilt are the main textures in the cores sediments of study area with share of sand and siltysand texture in some studied area especially in cores 1 and 6. Mica group minerals (Biotite and Chlorite), Ultra stable group (Tourmaline , Zircon, and Rutile) , un- stable group mineral (Pyroxene, Augite, and Hornblend) , meta- stable group mineral (Garnet, Kyanite, Epidote, Staurollite, and Cellestite) and Opaque minerals were the main of heavy minerals. Quartz, Feldspar, Calcite and Gypsum are the main light minerals in the marine core sediments. Montmorillonite- Chlorite, Palygoreskite-Illite, Chlorite, Montmorillonite and Kaolinite are the most of clay minerals component, with share small amount of Illite, and Palygoreskite. Hydraulic sorting mechanisms caused to make some relationship between mineral abundances and sediments texture. SEM mapping for light minerals showed some heavy metals that adsorbed on these minerals such as Cr, Ni, Br, Ge, Pb and Fe, Ta, and Ti elements.

KEYWORDS

Marine, Sediments, Umm Qasir, Heavy minerals, Quaternary, Shytianah , Khors

Introduction

The Arabian Gulf is a foreland basin that lies between the Arabian Shield and the Zagros fold belt. Today, it is being in filled at its northern head by the Tigris-Euphrates-Karun delta, receives further detrital sediment from Iran on its NE flank, and along its Arabian flank is the site of carbonate and evaporate sedimentation (Frédéric and Bruce, 1990). Mineralogy studies on Iraqi marine Quaternary deposits received little attention, but there were many of studies that take textures and minerals studies of Iraqi coastlines. Basi et al (1989) concluded that montmorillonite (6-26%), kaolinite (9-29%), chlorite (6-26%) and illite-palygoreskite (15-49%) as a major clay minerals in the Khor Al-Zubair estuary. AlBadran and AlBadran (1993) classified the texture of offshore sediments of Khor Abdullah entrance to sandy sity clay, silty clay sand, and clayey sand. Al-Marsoumi and Darmoian(2000) mentioned the mineralogy analysis of the Northwest sediments of Arabian Gulf reveals the presence of low-Mg calcite, dolomite, high Mg-Calcite, aragonite, quartz , and feldspar. Wasel and Albadran (2003) indicated that the texture of Khor AlZubair was siltyclay and the texture of rocky area in this Khor was sandy sediments, and the opaque minerals, pyroxene, hornblende, and epidote minerals are most common of heavy minerals in the sediments of Khor AlZubair. Al-Marsoumi et al (2006) concluded that kaolinite, montmorillonite, palygoreskite, chlorite and mixed layers were most abundant clay minerals in the sediments of Khor Abdullah and heavy minerals proved that Khor Abdullah sediments mostly derived from igneous, with subordinate amount of metamorphic and ancient sedimentary rocks. Al-Mahmmod et al (2008) mentioned that the silt texture was the main in the estuarine of Shatt Al-Arab, and the sand increase towards the west of Arabian Gulf. Al-Jabbry (2009) determined that the texture of sediments in Khor Shytianah sediments is siltyclay and sandymud, and suggested that the high values of liquid limit for the sediments in this area attributed to the ability of clay minerals in the sediments to absorbed water. Issa et al (2009) emphasized that silt and clay texture of Khor AlZubair and Khor Abdullah sediments, with carbonate continents between 7.83-26.58 % and 23.38-45.54 % respectively. Al-Jaberi (2015) gave data about the mineral variation in the Iraqi coastlines, showed that Mica, un stable, opaque, meta-stable, ultra-stable are most groups of heavy minerals in the sediments ,while Kaolinite, palygorskite, chlorite, montmorillo nite, illite, mixed layers of chlorite-montmoillonite and illte-montmorillonite are most of clay minerals. Study of Al-Dabbas and Al-Jaberi (2015) showed that hydrochemical analysis reflects relatively three zones of water salinity namely Khor Abdullah with TDS ranges from 39,215 to 40,100 ppm, Khor Shytianah with TDS ranges from 44,620 to 45,220 ppm and Hacham Island with TDS ranges from 41,190 to 41,220 ppm. Al-Jaberi (2017) gave data about clay minerals for quaternary sediments in Basrah city – south Iraq , showed that Kaolinite, Illite, Palygoreskite, Illite-Palygorestike mixed layer, Chlorite, Montmorillonite, Vermiculte, and mixed layers of Illite-Smectite are the most quantitatively important phyllosilicates minerals.

Study area

Study area is located in the north and Northwest of Arabian Gulf between Umm Qasir and Basrah oil port (N 30°01'72.2´´- N 29°43'56.5´´ and E 48°06'41.9´´- E 48°37´71.4´´) as showed in figure (1) and table (1).

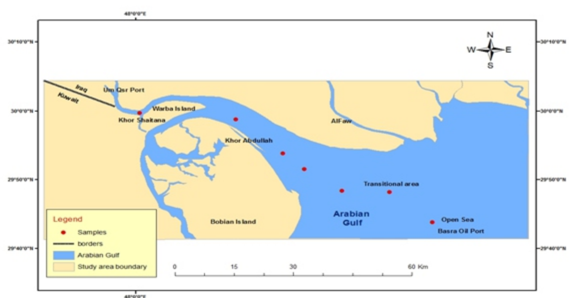


Fig 1- Map of study area

Material methods

The core samples (S1 to S7) (Figure 1), approximately 5 cm in diameter, had been split to A (0-5 cm) , B (5-10 cm) , C (10-15 cm), D (15-20 cm), E (20-25 cm) , and F (25-30 cm) . Each individual sample was placed in distilled water and disaggregated with a mechanical mixer. The suspension was then passed through a 300- mesh ASTM sieve and the material retained on the sieve was dried and saved for microscopic study. Light and heavy minerals for core samples were measured using the Polarizer and Scanning Electron Microscope. The clay fraction (<2 F) was separated by a sedimentation procedure. Sodium Hexametaphosphate was used as the dispersing agent when needed. Clay minerals were measured using x-ray diffraction for three stages (Normal, Ethylene Glycol, and heating 550 °c).

Location and description of the cores

The cores used in this study were collected during the year 2016. The cores studied were from the seven stations of Iraqi marine sediments. These cores collected by use Core Sampler Instrument (Figures 2 A,B) . The following table (1) shows some of the pertinent data for each core:

Table 1- Pertinent data of studied cores

Core No.	Area name	water Depth (m)	Latitude	Longitude
1	Khor Shytianah	10	N 30°01'72.2´´	E 48°06'41.9´´
2	Khor Abdullah 1	10	N 29°59'92.3´´	E 48°12'92.3´´
3	Khor Abdullah 2	11	N 29°54'04.7´´	E 48°18'95.6´´
4	Khor Abdullah 3	12	N 29°53'44.8´´	E 48°20'72.8´´
5	Khor Abdullah 4	12	N 29°49'98.3´´	E 48°27'03.3´´
6	Transitional area	14	N 29°47'45.4´´	E 48°32'37.9´´
7	Basrah oil port(open sea)	15	N 29°43'56.5´´	E 48°37´71.4´´

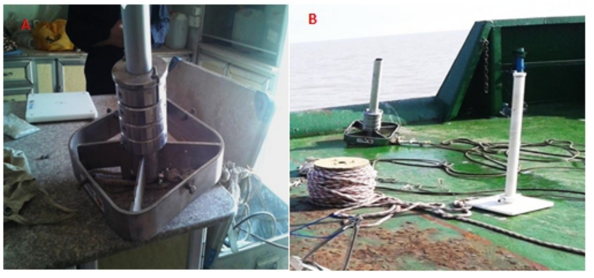


Fig 2- Core Sampler Instrument

Aim of study

This study had several objectives which can be enumerated as follows:

1. To recognize the heavy and clay minerals present in these particular recent marine sediments.
2 - To see if depth of water has any effect on these minerals.
3- To study the heavy and clay minerals from top to bottom of the cores at closely spaced intervals and see if there are any minerals variations.

Results and discussion

Heavy, light and clay minerals distribution, diversity and occurrence in the marine sediments considered as a key issue in the understanding on the overall behavior, characteristics and genesis of the entire sedimentary environment. These minerals were measured according to regular depth intervals for seven marine core sediments, with total of 32 samples that collected from these cores in the north and Northwest of Arabian Gulf were investigated in this study. Texture analysis showed that muddy sediments with shells dominate in the most cores , but the sand sediments exist in the some depth intervals, especially in core 1 (sand reached 95%) and core 6 (sand reached to 63%) (Table 2) (Figures 3 A, b, and C). High sand content in core 1 may attributed to effected by Kuwait marine currents, while sand content in core 6 may attributed to turbidity currents that effect from Shatt Al-Arab delta. Mica group minerals (Biotite and chlorite), Ultra stable group (Tourmaline , zircon, and rutile) , un- stable group mineral (Pyroxene, augite, and hornblend) , meta- stable group mineral (Garnet, kyanite, epidote, staurollite, and cellestite) and opaque group minerals were the main of heavy minerals in the study area (Tables 3 to 8) (Figures 4 to 12) . Various factors that affected on heavy minerals assemblages. These factors represented by weathering at different stages between the original source rocks and new sedimentary basin, mechanical abrasion during transportation, physical sorting , and diagenetic processes during burial (Morton et al ., 2005 ; Bateman and Catt , 2007). Rutile , zircon, epidote , biotite , and opaque minerals increased significantly in the interval from 0 to 5 cm for almost cores and start decreased abundance down the bottom. Garnet, hornblend, and chlorite minerals, found especially in the interval from 10 to 15 cm and decreased toward the bottom, and eventually it vanished in the interval from 25 to 30 cm especially for chlorite mineral. Increased abundance of pyroxene mineral in the interval from 5 to 10 cm and start to decreased of abundance towards the bottom. Kyanite abundance presented especially in the interval from 10 to 20 cm , while cellestite mineral present just at depth interval from 15 to 20 cm in cores 5 and 6 and vanished in the other depths. On the other hand, there are relationships between grain size texture and type of heavy minerals. Biotite, zircon, rutile, and opaque minerals found with high percentages in large size particle (sand and siltysand textures), while hornblende, chlorite, garnet, cellestite, staurollite, and tourmaline minerals found in the fine size particle (silt and sandysilt textures) . Slingerland and Smith (1986) estimated four hydraulic sorting mechanisms that could affect heavy minerals concentration. These mechanisms are entrainment sorting, transport sorting, shear sorting and suspension sorting. Fletcher et al (1992) concentrated on the behavior of heavy mineral grains and their relation to transport velocity. Haredy (2003) concluded that provenance, stability level of minerals, sea level fluctuations during the quaternary, offshore and the longshore drift currents, variation in fluvial and aeolian supplies to the marine systems have all influences the nature, concentration and distribution of heavy minerals over the shelves and coastal marine sediments. Quartz, feldspar, calcite and gypsum are the most of light minerals in the sediments of study area, with share of some fragment shells (Tables 3 to 8) (Figures 3to15). Abundances of each of quartz, feldspar, and calcite deceased toward the bottom, while gypsum mineral abundance increase in the interval from 10 to 15 cm compare with the other depths. Abundance of quartz and feldspar increased in the large particle size (sand and siltysand textures), while calcite and gypsum found in the fine particle size (silt and sandysilt textures) (Figures 18 to 24). SEM mapping for quartz and feldspar minerals which showed abundance of some elements, especially heavy elements that absorption on the surface of quartz and feldspar like (Cr, Ni, Br, Ge, Pb and Fe, Ta, and Ti) may gave indicate to pollution conditions in this area as showed in figures (Figures 16 and 17).

Table 2- Grain size analysis and sediments texture of study area

	Sample Name	Depth (cm)	Sand %	Silt %	Clay %	Texture	Shells Wt%	Original Sand %
core 1	1A	0-5	95	4	1	Sand	5	90
	1B	5-10	70	20	10	Silty Sand	8	62
	1C	10-15	69	27	4	Silty Sand	9	60
Core 2	2A	0-5	٤٠	54	6	Sandy Silt	8	32
	2B	5-10	8	80	12	Silt	1	7
	2C	10-15	6	75	19	Silt	1	5
Core 3	3A	0-5	37	51	12	Sandy Silt	9	28
	3B	5-10	36	50	14	Sandy Silt	10	26
	3C	10-15	36	52	12	Sandy Silt	9	27
	3D	15-20	33	53	14	Sandy Silt	8	25
Core 4	4A	0-5	6	75	19	Silt	-	6
	4B	5-10	4	73	23	Silt	-	4
	4C	10-15	4	64	31	Silt	-	4
	4D	15-20	5	64	31	Silt	-	5
	4E	20-25	6	72	22	Silt	-	6
	4F	25-30	4	74	22	Silt	-	4
Core 5	5A	0-5	3	84	13	Silt	-	3
	5B	5-10	4	80	16	Silt	-	4
	5C	10-15	5	84	11	Silt	-	5
	5D	15-20	6	83	11	Silt	-	6

	5E	20-25	6	81	13	Silt	-	6
	5F	25-30	7	82	11	Silt	-	7
Core 6	6A	0-5	43	52	5	Silty Sand	13	30
	6B	5-10	50	41	9	Silty Sand	15	35
	6C	10-15	53	40	7	Silty Sand	19	34
	6D	15-20	60	32	8	Silty Sand	28	32
	6E	20-25	63	29	8	Silty Sand	42	21
Core 7	7A	0-5	4	75	21	Silt	0.7	3.3
	7B	5-10	7	82	11	Silt	1	6
	7C	10-15	31	56	13	Sandy Silt	15	16
	7D	15-20	63	31	6	Silty Sand	37	26

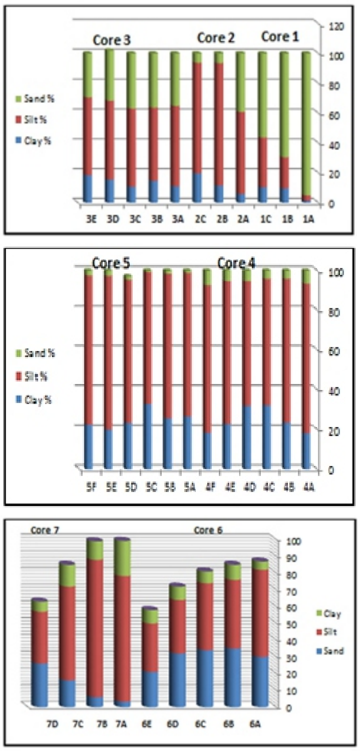


Fig 3- A, B, and C - Grain size analysis for core sediments

Table 3- Heavy minerals assemblages in core 1 and 2

	Core 1				Core 2			
Depth(Cm) / Heavy minerals	0-5	5-10	10-15	Average	0-5	5-10	10-15	Average
	1A	1B	1C		2A	2B	2C	
Hornblende %	5	8	9	7	7	6	7	7
Biotite %	17	15	12	14	7	6	7	7
Chlorite %	10	17	19	15	17	17	18	17.3
Garnet %	2	1	1	1.3	4	4	5	4.3
Cellestite %	-	-	1	1	2	1	2	2
Staurollite %	1	3	5	3	3	4	5	5
Zircon %	15	11	19	12	9	6	6	3
Rutile %	10	5	2	5.6	5	5	3	4.3
Kynite %	5	2	1	2	1	1	1	2
Tourmaline%	2	2	3	2	5	3	5	4.3
Epidote %	7	5	4	5.3	6	5	2	4.3
Pyroxene %	4	2	5	3.6	9	9	8	9
Augite %	-	-	\	\	-	\	\	\
Opique %	25	29	28	27	24	26	24	25
Light minerals								
Quartz %	45	42	41	42.6	35	33	35	34.3
Feldspar %	22	23	21	22	25	29	27	27
Calcite %	28	26	27	27	31	23	15	23
Gypsum %	6	9	11	8.6	8	15	23	15.3

Table 4- Heavy minerals assemblages in core 3

	Core 3					
Depth(Cm) / Heavy minerals	0-5	5-10	10-15	15-20	20-25	Average
	3A	3B	3C	3D	1E	
Hornblende %	7	11	14	7	15	14
Biotite %	6	8	14	5	10	7
Chlorite %	19	18	11	14	14	19
Garnet %	5	0	5	5	1	070
Cellestite %	1	1	1	1	1	1
Staurollite %	1	1	1	1	5	170
Zircon %	14	8	5	17	9	9
Rutile %	1	1	1	1	7	1
Kynite %	1	0	5	1	1	0
Tourmaline%	1	5	7	0	1	0
Epidote %	7	5	5	1	1	0
Pyroxene %	9	14	15	11	11	11
Augite %	-	-	-	1	-	-
Opique %	10	11	11	11	11	11
Light minerals						
Quartz %	10	15	16	11	11	10
Feldspar %	18	18	11	19	16	1878
Calcite %	10	11	18	11	11	1176
Gypsum %	10	10	11	18	19	1576

Table 5- Heavy minerals assemblages in core 4

	Core 4						
Depths (Cm) / Heavy minerals	0-5	5-10	10-15	15-20	20-25	25-30	Average
	4A	4B	4C	4D	4E	4F	
Hornblende %	9	14	11	11	14	14	11
Biotite %	14	8	7	8	7	6	7
Chlorite %	10	17	15	16	15	15	15
Garnet %	1	1	0	1	1	1	1
Cellestite %	1	1	1	1	1	1	170
Staurollite %	5	1	1	7	6	6	5
Zircon %	9	7	7	7	9	8	7
Rutile %	1	1	1	0	1	1	176
Kynite %	1	1	0	1	1	1	1
Tourmaline%	0	7	9	6	5	5	6
Epidote %	7	5	0	1	6	6	5
Pyroxene %	5	5	6	6	8	14	7
Augite %	-	-	-	-	-	-	-
Opique %	11	14	19	18	16	19	1878
Light minerals							
Quartz %	10	11	11	11	19	14	1175
Feldspar %	14	11	15	10	14	11	11
Calcite %	17	19	16	15	11	14	1871
Gypsum %	19	17	17	14	19	18	1871

Table 6- Heavy minerals assemblages in core 5

	Core 5						
Depths (Cm) / Heavy minerals	0-5	5-10	10-15	15-20	20-25	25-30	Average
	5A	5B	5C	5D	5E	5F	
Hornblende %	15	11	6	7	7	6	876
Biotite %	9	14	14	7	14	14	971
Chlorite %	19	17	17	16	11	15	16
Garnet %	1	1	1	1	0	1	1
Cellestite %	1	-	-	1	1	1	1
Staurollite %	1	0	0	5	6	5	075
Zircon %	8	11	15	6	8	11	14
Rutile %	0	1	1	1	5	0	171
Kynite %	1	1	1	0	1	0	178
Tourmaline%	0	1	1	0	0	0	176
Epidote %	1	6	5	8	6	7	7
Pyroxene %	5	7	6	5	1	6	571
Augite %	-	-	-	-	1	-	1
Opique %	15	17	18	11	11	11	1078
Light minerals							
Quartz %	18	15	15	18	17	17	1071
Feldspar %	11	14	17	11	19	14	1976
Calcite %	18	14	11	16	11	15	1478
Gypsum %	11	15	15	15	11	18	1178

Table 7- Heavy minerals assemblages in core 6

	Core 6					
Depth(Cm) / Heavy minerals	0-5	5-10	10-15	15-20	20-25	Average
	6A	6B	6C	6D	6E	
Hornblende %	9	15	19	17	11	10
Biotite %	14	11	10	11	13	11
Chlorite%	10	10	14	16	11	11
Garnet %	8	0	0	5	1	076
Cellestite %	1	1	1	0	1	178
Staurollite %	5	0	1	0	5	0
Zircon %	9	9	11	14	14	9
Rutile %	6	5	5	1	6	5
Kynite %	5	1	0	1	0	176

Tourmaline%	1	0	1	0	6	178
Epidote %	0	0	5	6	5	078
Pyroxene %	1	1	1	6	8	070
Augite %	-	-	-	-	1	1
Opique %	11	14	19	14	16	1776
Light minerals						
Quartz %	17	15	18	10	15	1578
Feldspar %	11	14	11	11	18	1476
Calcite %	11	11	11	10	18	1176
Gypsum %	14	11	9	14	19	11

Table 8- Heavy minerals assemblages in core 7

Core 7					
Depth(Cm) / Heavy minerals	0-5 7A	5-10 7B	10-15 7C	15-20 7D	Average
Hornblende %	9	11	16	11	11
Biotite %	15	16	19	11	16
Chlorite %	15	18	15	10	16
Garnet %	1	1	1	1	1
Cellestite %	1	1	1	1	1
Staurollite %	0	5	0	1	0
Zircon %	11	14	11	9	11
Rutile %	0	1	0	1	1
Kynite %	1	1	1	0	1
Tourmaline%	1	1	1	5	1
Epidote %	9	7	5	0	7
Pyroxene %	6	0	1	11	0
Augite %	1	-	-	1	1
Opique %	14	14	18	19	15
Light minerals					
Quartz %	14	10	17	11	1175
Feldspar %	14	19	17	14	1471
Calcite %	15	10	16	15	15
Gypsum %	15	11	14	11	1175

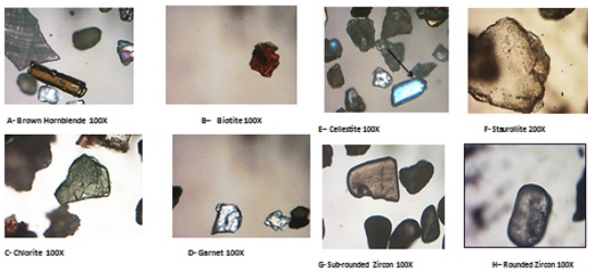


Fig 4- Heavy minerals under polarizer microscope. A- Brown hornblende 100x, B- Biotite 100x, C- Chlorite 100x , D- Garnet 100x, E- Cellestite 100x, F- Staurollite 200x, G- Zircon 100x, H- Zircon 100x

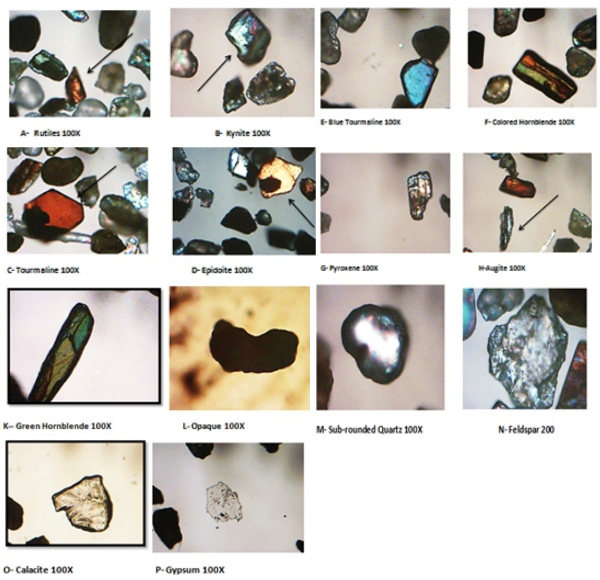


Fig 5- Heavy minerals under polarizer microscope , A- Rutile 100x , B- Kyanite 100x, C- Tourmaline 100x, D- Epidote 100x, E- Blue tourmaline 100x, F- Hornblende 100x, G- Pyroxene 100x, H- Augite 100x , K- Green Hornblende 100x , L- Opaque 100x, M- Quartz 100x , N- Feldspar 200x , O- Calcite 100x , P- Gypsum 100x.

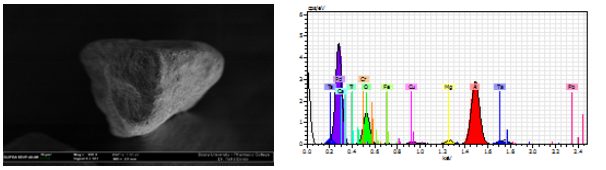


Fig 6- Image of garnet mineral and its spectrum under SEM-EDAX

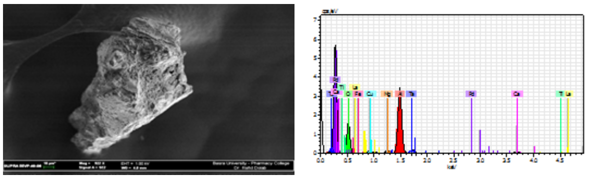


Fig 7- Image of Epidote mineral and its spectrum under SEM-EDAX

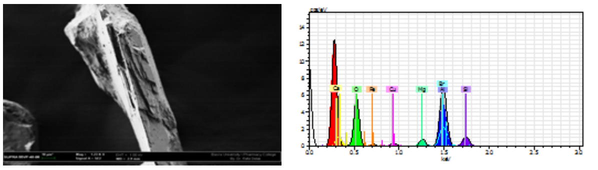


Fig 8- Image of Tourmaline mineral and its spectrum under SEM-EDAX

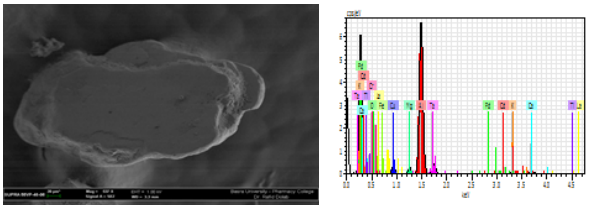


Fig 9- Image of Hornblende mineral and its spectrum under SEM-EDAX

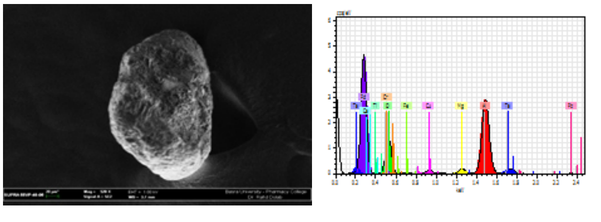


Fig 10- Image of Biotite mineral and its spectrum under SEM-EDAX

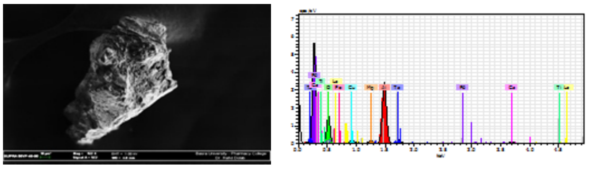


Fig 11- Image of Rutile mineral and its spectrum under SEM-EDAX

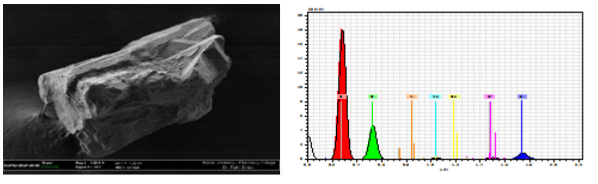


Fig 12- Image of Pyroxene mineral and its spectrum under SEM-EDAX

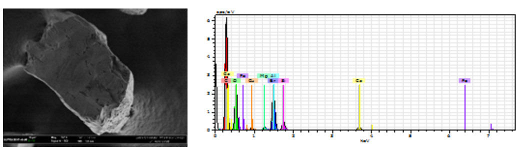


Fig 13- Image of Quartz mineral and its spectrum under SEM-EDAX

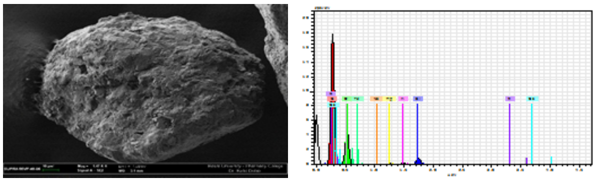


Fig 14- Image of Anorthite feldspar mineral and its spectrum under SEM-EDAX

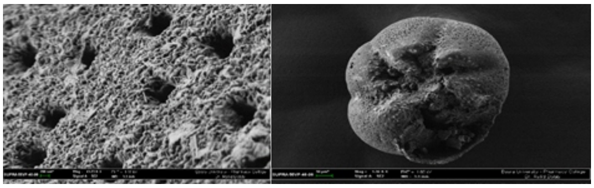


Fig 15- A/ Foraminifera, B/ Holes in the wall of Foraminifera, under SEM-EDAX

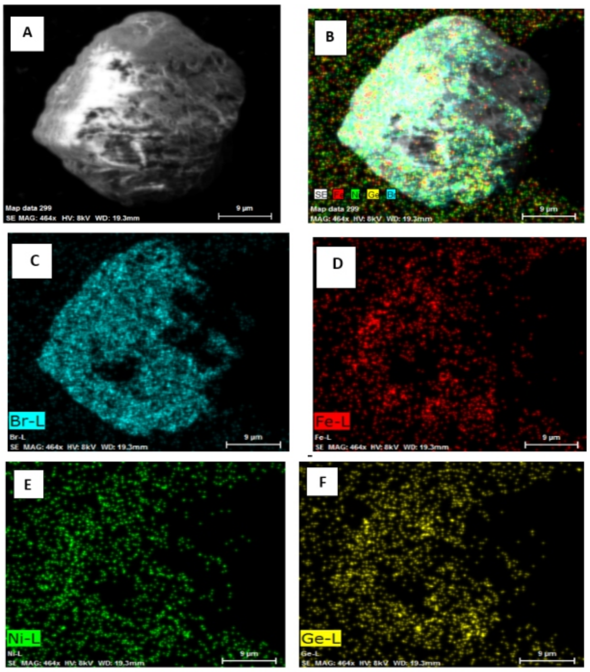


Fig 16- A-Quartz grain, B- Mapping of all adsorption elements on quartz surface, C, D, E, and F- Mapping of single adsorption elements

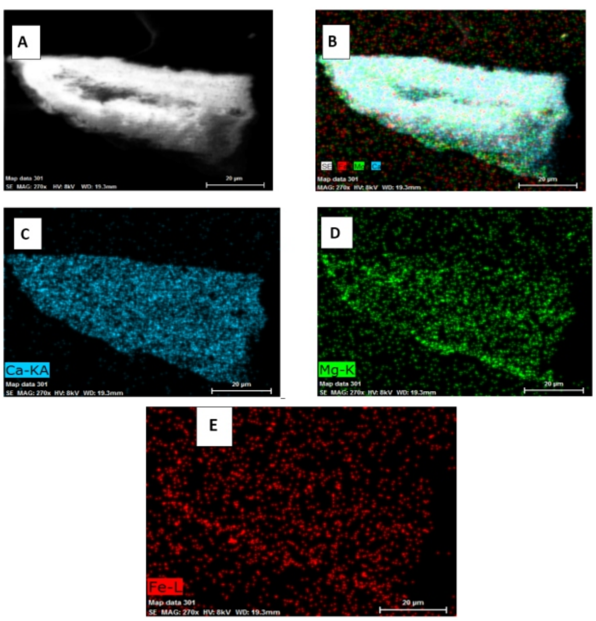


Fig 17- A- Anorthite feldspar grain, B- Mapping of all adsorption elements on Feldspar surface, C, D, and E- Mapping of single adsorption elements

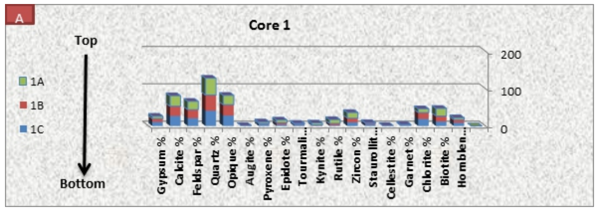


Fig 18- Light and heavy mineral variation with depth in core 1

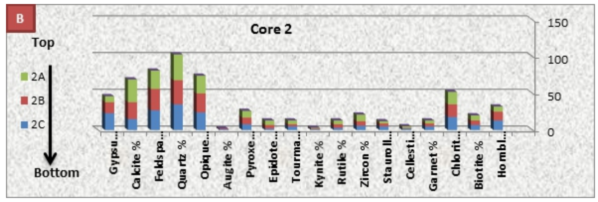


Fig 19- Light and heavy mineral variation with depth in core 2

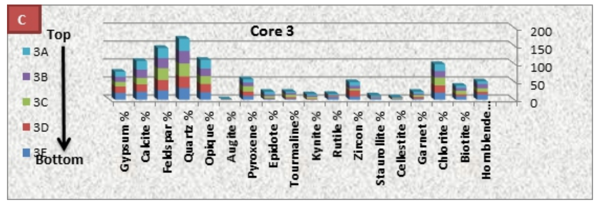


Fig 20- Light and heavy mineral variation with depth in core 3

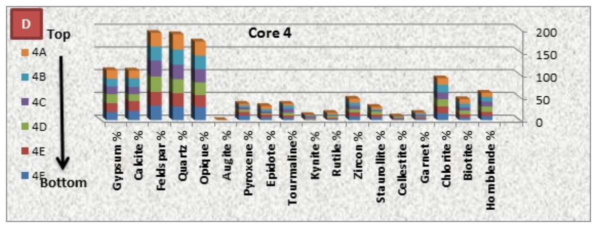


Fig 21- Light and heavy mineral variation with depth in core 4

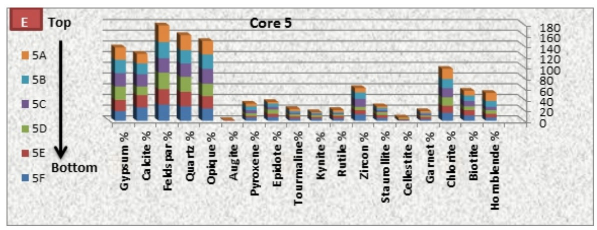


Fig 22- Light and heavy mineral variation with depth in core 5

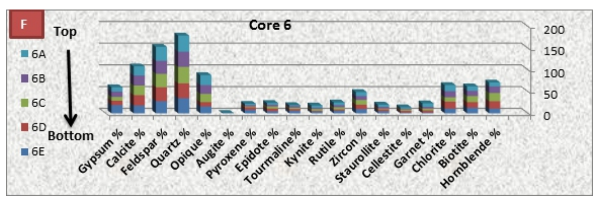


Fig 23- Light and heavy mineral variation with depth in core 6

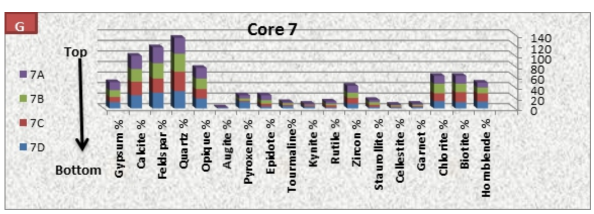


Fig 24- Light and heavy mineral variation with depth in core 7

Clay minerals composition of a series of core samples from top to bottom sediments of the north and Northwest of Arabian Gulf showed that Montmorillonite- Chlorite, Palygoreskite-Illite, Chlorite, Montmorillonite and Kaolinite respectively are the most of clay minerals component, with share small amount of Illite, and Palygoreskite . Study of clay minerals variation from the top of the core to the bottom showed that Montmorillonite- Chlorite, Palygoreskite - Illite and illite found at the top 0-5 cm of all cores and decreased toward bottom . Chlorite and kaolinite minerals presented in the interval from 15 to 20 cm and decrease toward tops.

Table 9- Clay mineral assemblages in cores 1 and 2

	Core 1					Core 2				
Depth(Cm) / Clay minerals	0-5	5-10	10-15	Average	Range	0-5	5-10	10-15	Average	Range
	1A	1B	1C			2A	2B	2C		
M-Ch %	05	04	40	41.6	40-45	06	-	32	39	-4611
P-I %	10	19	18	14711	18-24	-	18	16	17	16-18
Ch %	5	14	15	13.3	5-51	5	04	25	23.3	5-40
M %	9	7	14	8766	7-10	9	11	-	9	7-11
K %	17	10	11	15	13-17	19	19	11	14	119-2
I %	-	-	-	-	-	11	11	6	1975	6-21
P %	-	-	0	0	0	-	-	-	-	-

Table 10- Clay mineral assemblages in core 3

	Core 3						
Deth(Cm) / Clay minerals	0-5	5-10	10-15	15-20	20-25	Average	Range
	3A	3B	3C	3D	E1		
M-Ch %	-	16	10	28	18	1675	16-34
P-I %	16	19	20	14	19	1976	14-26
Ch %	51	10	20	18	11	1171	22-52
M %	6	7	-	-	-	675	6-7
K %	16	16	16	18	17	1676	16-18
I %	-	-	10	8	11	976	8-11
P %	-	8	-	0	1	5	3-8

Table 11- Clay mineral assemblages in core 4

	Core 4							
Depth(Cm) / Clay minerals	0-5	5-10	10-15	15-20	20-25	25-30	Average	Range
	4A	4B	4C	4D	4E	4F		
M-Ch %	08	06	05	08	-	-	06775	45-48
P-I %	11	11	11	-	16	11	11	21-26
Ch %	1	5	5	0	09	00	15766	2-49
M %	0	5	5	7	8	10	7711	4-15
K %	17	16	15	14	17	18	17716	15-20
I %	5	7	8	14	-	1	870	2-20
P %	1	-	-	1	-	-	1	1-1

Table 12- Clay mineral assemblages in core 5

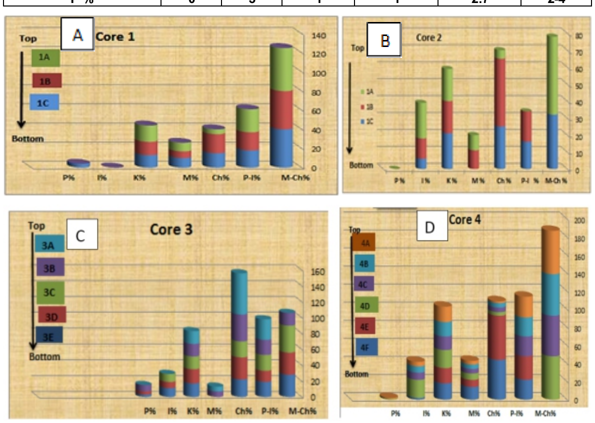
	Core 5							
Depth(Cm) / Clay minerals	0-5	5-10	10-15	15-20	20-25	25-30	Average	Range
	5A	5B	5C	5D	5E	5F		
M-Ch %	11	15	19	-	14	-	10	20-29
P-I %	15	17	17	-	-	-	16.3	15-17
Ch %	19	14	18	54	11	05	34	20-50
M %	14	11	6	8	14	11	14.3	6-21
K %	9	10	14	17	11	16	1076	9-20
I %	0	1	-	14	14	17	11	3-20
P %	1	-	-	5	6	1	176	1-3

Table 13- Clay mineral assemblages in core 6

	Core 6						
Depth(Cm) / Clay minerals	5	5-10	10-15	15-20	20-25	Average	Range
	6A	6B	6C	6D	6E		
M-Ch %	51	06	00	04	-	0575	40-52
P-I %	18	11	10	11	16	1671	12-21
Ch %	-	10	19	18	04	1177	14-40
M %	5	0	-	5	11	971	4-32
K %	15	17	15	10	8	15.8	8-25
I %	-	7	5	-	1	5	3-7
P %	-	-	1	1	1	2	1-3

Table 14- Clay mineral assemblages in core 7

	Core 7					
Depth(Cm) / Clay minerals	0-5	5-10	10-15	15-20	Average	Range
	7A	7B	7C	7D		
M-Ch %	54	33	-	-	0175	33-50
P-I %	-	15	18	-	1675	15-18
Ch %	6	22	61	01	11	6-61
M %	5	16	0	17	11	4-27
K %	10	11	15	14	1175	10-15
I %	11	-	-	18	1975	18-21
P %	0	3	1	1	2.7	2-4



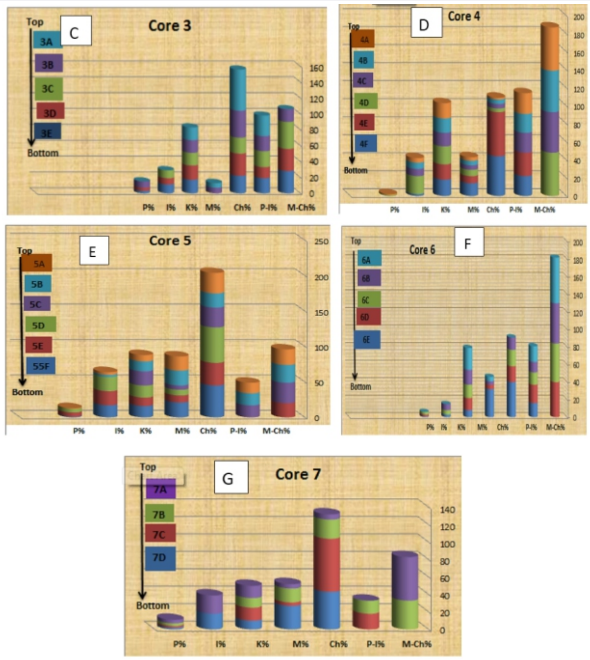


Fig 25 - A, B, C, D, E, F and G – Clay minerals variation with depths in cores 1 t0 7

Conclusion

1- Muddy sediments are the dominant texture in Iraqi marine sediments.
2- Effect of Kuwait marine currents on closed Iraqi marine areas caused to increase sand percentages in core 1, while the effect of turbidity current from Shatt Al Arab delta on north of Arabian Gulf caused to increase sand content in core 6.
3- Rutile, Zircon, Epidote, Biotite, and Opaque minerals presented at high abundance in the top sediment cores (0 to 5 cm) and decreased downward cores.
4- Garnet, Hornblende and Chlorite presented in high abundance in the interval from 10 to 15 cm
5- Pyroxene presented in high abundance in the interval from 5 to 10 cm and decreased toward the bottom. While Kyanite abundance presented especially in the interval from 10 to 20 cm
6- Biotite, Zircon, Rutile and Opaque minerals presented with high abundance in the sand and siltysand. On the other hand , Hornblende, Chlorite, Garnet, Cellestite, Staurollite, and Tourmaline presented with high abundance in the silt and sandysilt.
7- Quartz, Feldspar, and Calcite decreased in their abundance toward the bottom.
8- Quartz and feldspar increased in their abundance in the sand and siltysand texture. while calcite and gypsum increased in the silt and sandysilt texture.
9- Montmorillonite-Chlorite, Palygoreskite- Illite, and illte found with high abundance at the top cores and decreased downward the bottom, while chlorite and kaolinite presented with higher abundance in the bottom and decreased upward.

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