Mineralogical and Geochemical Study of Sediments of Lower Mesopotamia, Southern Iraq

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ABSTRACT

This study is based on forty eight samples that were collected from selected sites in Lower Mesopotamia. Sampling depth varies between 1 and 9 m in the South Hammar Marsh, Southern. Grain size distribution indicates that the deposits are mainly composed of silt with a small amount of clay and sand, silt texture is dominate in the sediments, followed by sandy silt, mud, and muddy sand. The dominate nonclay minerals are calcite, quartz, dolomite, feldspar and gypsum, while the clay minerals are composed of; kaolinite, illite, montmorillonite, chlorite, Palygorskite, mixed layers montmorillonite - chlorite and palygorskite - illite. Chemical analysis showed that all samples have high concentration in SiO_2 and CaO in comparison with Al_2O_3, Fe2O_3, MgO, SO_3, K_2O and Na_2O. These results are generally related to the clay minerals composition. The depositional environment of these minerals may be characterized by an arid to semi-arid climate in the source area.

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1. Introduction

The Mesopotamian plain in the lower is a broad, flat deltaic complex with shallow freshwater marshes such as Baghdad and Zechri, and brackish water like Shafi and Hammar marshes which though to be formed as young as 640-552 BP [1] with around <3 m depth surrounded by extensively vegetated marshes, locally called the Ahwar. Quaternary deposits (1.65 M.Y) are considered widespread constitutes, more than one third of the surface sediments of Iraq. The Mesopotamian plain is mostly covered by sediments of the Quaternary period [2], where these sediments consist largely of silt and clay with a little amount of sand fraction. Unfortunately, very few systematic clay mineralogical studies have been done on the lower Mesopotamian plain; studied the heavy mineral composition of the sand fraction of Tigris and Shatt Al-Arab Rivers and identified the dominate mineral in the sediments of Tigris, Euphrates and Shatt Al-Arab Rivers. The study of the distribution of the main elements in sediments is an important means of detecting the quality of source rocks and the geological and climatic conditions prevailing during weathering processes, as well as knowing the nature of subsequent sedimentary and diagenesis processes. The aim of this study is to clarify the weathering condition and ancient climate of the area.

2. Materials and Methods

Forty-eight sediment samples were collected from four boreholes were in study area (Fig. 1). The depth of coring was about 2m in site one, 4m at site two, and in sites three and four were 9 meters in the sites one, two, three, and four by using two inches diameter tubes with one meter length connected by sockets and used for coring, using a hammer machine to push the tubes down the ground. Visual description and sampling were done in the tunnel with depth (Fig. 2) which was drawn by Sedlog 3.0 program. Grain size analysis is carried out to separate sand from silt and clay, using a sieve 0.063 mm by wet sieving. Forty- four samples were analyzed by X- Ray diffraction technique to identify both oriented clay samples and non- clay minerals of total sediments. The instrument used is *Bruker D2 Phaser* in the Iraqi German Laboratory / University of Baghdad/ College of Science/ Department of Geology. Target: Cu, Wave: 1.54060, Voltage: 40 KV, Current: 30 mA. Twenty two samples were analyzed for their major oxides (CaO, SiO_2, Al_2O_3, Fe_2O_3, MgO, Na_2O, SO_3, K_2O, TiO_3 and Loss on ignition). Major oxides elements were analyzed by using XRF techniques (XRF: Ed-XRF Instrument Spectro-Xepos of Ametek

Company, in the Iraqi German Laboratory in the University of Baghdad/ College of Science / Department of Geology).

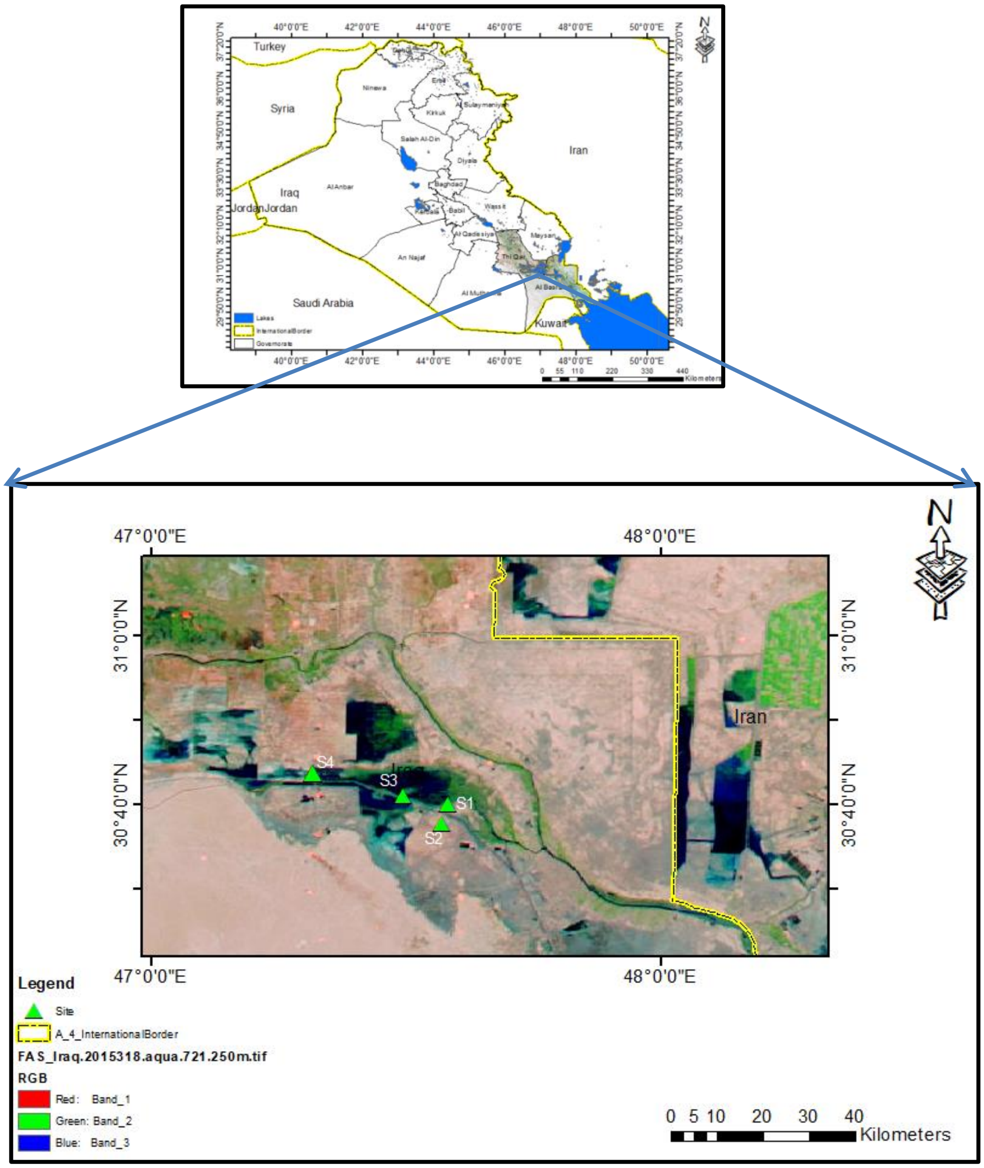

Figure 1: Map of study area

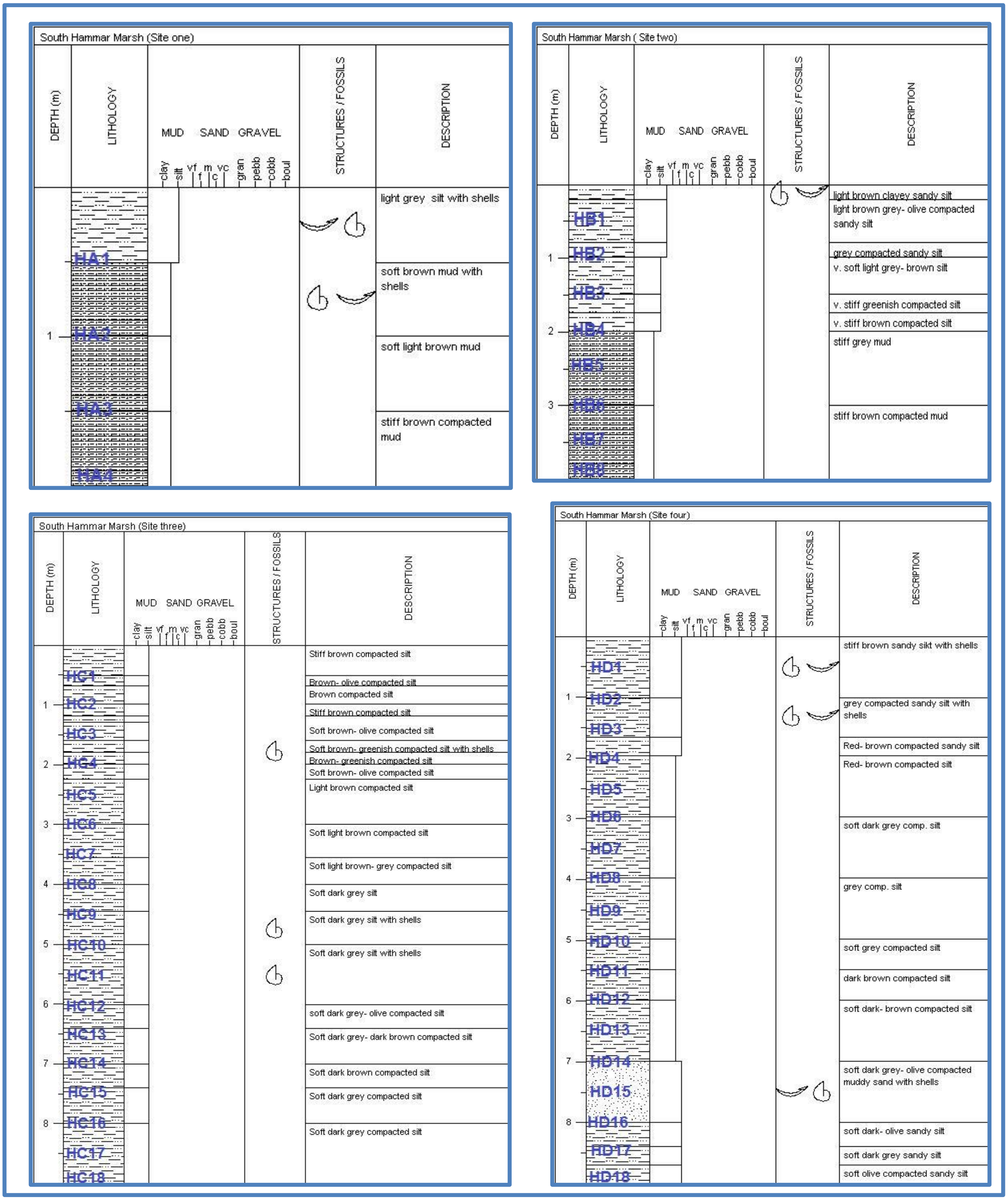

Figure 2: Lithology of sites 1, 2, 3, and 4

3. Results and Discussion

3.1 Grain size analysis

The results of the grain size analysis are given in Tables 1, 2, 3, and 4 for forty eight samples, which show the percentages of sand, silt, and clay. Clay was low percent in selected samples (1-26) % with an average of 5.35%, while the silt portion is high percent in all samples, it ranged between (36- 98) % with an average of 86.45%, While the extent of sand in the sediments of the study area was (1- 62) % with an average of 8.2%. The color of sediments is light olive to grey indicating anaerobic and quiet environment conditions.

Table 1: Grain size Percentage and statistical parameters of south Hammar marsh in site one.

Sample	Depth	Sand%	Silt%	Clay%	Lithology	Mean	median	Sorting	Kurtosis	Skewness
HA1	0-0.5	6	90	4	Silt	6.5	6.4	1.6	0.89	0.04
HA2	0.5-1	6	78	19	Mud	6.4	6.8	1.58	0.85	-0.01
HA3	1-1.5	4	82	14	Mud	6.4	6.5	1.45	0.75	-0.03
HA4	1.5-2	3	83	14	Mud	6.4	6.7	0.73	0.75	-0.01

Table 2**:** Grain size Percentage and statistical parameters of south Hammar marsh in site two.

Sample	Depth	Sand%	Silt%	Clay%	Lithology	Mean	median	Sorting	Kurtosis	Skewness
HB1	0-0.5	14	82	4	Sandy silt	6.3	6.2	1.6	0.85	0.04
HB2	0.5-1	16	81	3	Sandy silt	6.2	6.3	1.5	0.85	0.04
HB3	1-1.5	7	90	3	Silt	6.5	6.4	1.6	0.89	0.04
HB4	1.5-2	7	89	4	Silt	6.3	6.7	1.23	0.83	-0.15
HB5	2-2.5	2	76	26	Mud	6.3	6.6	1.57	0.84	-0.03
HB6	2.5-3	3	71	22	Mud	6.4	6.8	1.58	0.85	-0.01
HB7	3-3.5	3	79	18	Mud	6.2	6.3	1.5	0.85	0.04
HB8	3.5-4	3	81	16	Mud	6.5	6.4	1.6	0.89	0.0r4

Table 3: Grain size Percentage and statistical parameters of south Hammar marsh in site three.

Sample	Depth	Sand%	Silt%	Clay%	Lithology	Mean	median	Sorting	Kurtosis	Skewness
HC1	0-0.5	7	92	2	Silt	6.3	6.7	1.35	1.13.	0.04
HC2	0.5-1	8	90	2	Silt	6.4	6.4	1.25	0.81	-0.20
HC3	1-1.5	6	93	1	Silt	6.3	6.7	1.23	0.83	-0.15
HC4	1.5-2	7	91	2	Silt	6.3	6.6	1.57	0.84	-0.03
HC5	2-2.5	6	89	5	Silt	6.4	6.8	1.58	0.85	-0.01
HC6	2.5-3	2	95	3	Silt	6.4	6.4	1.62	0/87	-0.04
HC7	3-3.5	1	98	1	Silt	6.5	6.5	1.59	0.72	-0.02
HC8	3.5-4	1	95	4	Silt	6.3	6.3	1.63	0.73	-0.01
HC9	4-4.5	1	96	3	Silt	6.4	6.5	1.45	0.75	-0.03
HC10	4.5-5	1	97	2	Silt	6.4	6.7	0.73	0.75	-0.01
HC11	5-5.5	1	98	1	Silt	6.3	6.7	1.35	1.13.	0.04
HC12	5.5-6	1	95	4	Silt	6.4	6.4	1.25	0.81	-0.20
HC13	6-6.5	1	96	3	Silt	6.3	6.7	1.23	0.83	-0.15
HC14	6.5-7	1	94	5	Silt	6.3	6.6	1.57	0.84	-0.03
HC15	7-7.5	2	93	5	Silt	6.4	6.8	1.58	0.85	-0.01
HC16	7.5-8	1	96	3	Silt	6.4	6.4	1.62	0/87	-0.04
HC17	8-8.5	1	96	3	Silt	6.5	6.5	1.59	0.72	-0.02
HC18	8.5-9	1	98	1	Silt	6.3	6.3	1.63	0.73	-0.01

Table 4: Grain size Percentage and statistical parameters of south Hammar marsh in site four

Sample	Depth	Sand%	Silt%	Clay%	Lithology	Mean	median	Sorting	Kurtosis	Skewness
HD1	0-0.5	22	75	3	Sandy silt	6.4	6.4	1.85	1.14	-0.18
HD2	0.5-1	18	77	5	Sandy silt	7.1	6.3	1.93	1.91	-0.21
HD3	1-1.5	20	76	4	Sandy silt	6.3	6.6	1.27	1.82	0.12
HD4	1.5-2	19	75	6	Sandy silt	7.2	6.5	1.26	1.92	0.13
HD5	2-2.5	7	90	3	Silt	6.3	6.7	1.35	1.13.	0.04
HD6	2.5-3	4	92	4	Silt	6.4	6.4	1.25	0.81	-0.20
HD7	3-3.5	1	95	4	Silt	6.3	6.7	1.23	0.83	-0.15
HD8	3.5-4	1	97	2	Silt	6.3	6.6	1.57	0.84	-0.03
HD9	4-4.5	2	97	1	Silt	6.4	6.8	1.58	0.85	-0.01
HD10	4.5-5	1	98	1	Silt	6.4	6.4	1.62	0/87	-0.04
HD11	5-5.5	2	97	1	Silt	6.5	6.5	1.59	0.72	-0.02
HD12	5.5-6	1	96	3	Silt	6.3	6.3	1.63	0.73	-0.01
HD13	6-6.5	1	97	2	Silt	6.4	6.5	1.45	0.75	-0.03
HD14	6.5-7	2	96	2	Silt	6.4	6.7	0.73	0.75	-0.01
HD15	7-7.5	60	38	2	Muddy sand	3.4	2.9	1.38	1.75	0.60
HD16	7.5-8	62	36	2	Muddy sand	3.9	3.4	1.35	1.66	0.58
HD17	8-8.5	25	70	5	Sandy silt	6.1	6.5	1.46	0.77	-0.02
HD18	8.5-9	23	73	4	Sandy silt	6.2	6.4	1.59	0.76	-0.04

3.2 Mineralogical analysis

The percentages of minerals were calculated by semi-quantitative method.

3.2.1 Non-clay minerals

Twenty- two samples were attended of both sites 1, 2, 3, and 4 and measured by (XRD) an angle of (2-60)2θ. Calcite, quartz, dolomite, feldspar and gypsum are most of minerals in the sediments of the studied area (Fig. 3 and Table5).

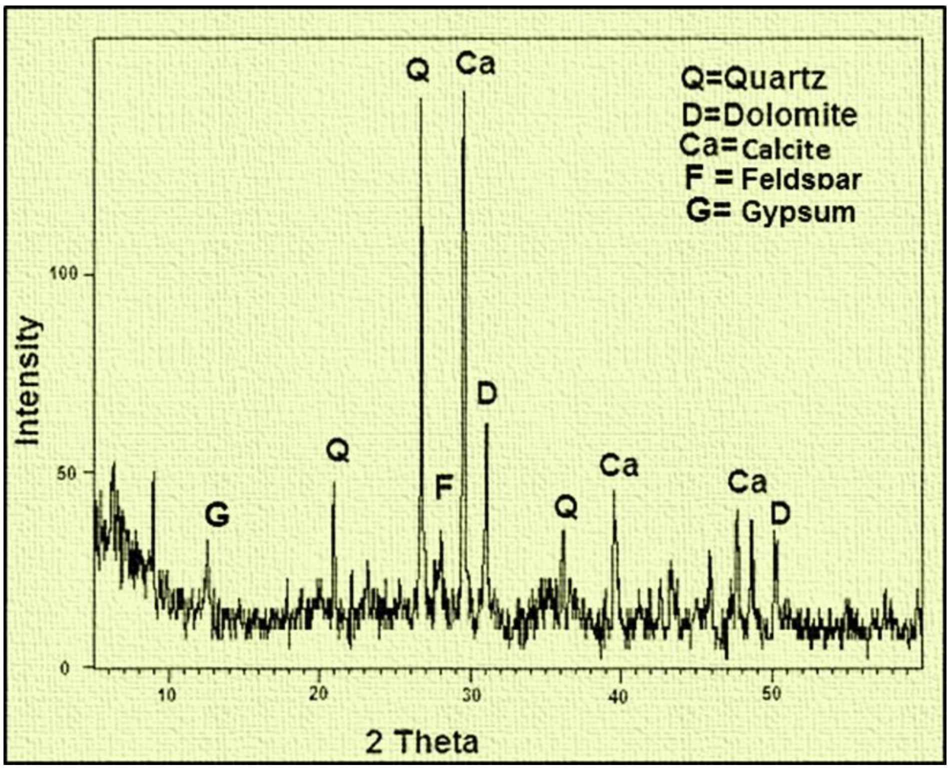

Figure 3: XRD diffractogram of Non-clay minerals.

Table 5: Percentage of non-clay minerals in south Hammar marsh sites

Site No.	Sample	Lithology	Depth (m)	Calcite%	Quartz%	Dolomite %	Feldspar %	Gypsum %
Site One	HA1	Silt	0-0.5	50	36	5	6	3
	HA2	Mud	0.5-1	44	37	9	7	3
	HA3	Mud	1-1.5	44	37	11	4	4
	HA4	Mud	1.5-2	52	33	6	3	6
	Range			(44- 52)	(33-37)	(5-11)	(3-7)	(3-6)
	Average			47.5	35.75	7.75	5	4
Site Two	HB1	Sandy silt	0-0.5	48	34	8	6	5
	HB2	Sandy silt	0.5-1	46	36	10	4	4
	HB3	Silt	2.5-3	40	31	15	7	7
	HB8	Mud	3.5-4	44	35	8	8	5
	Range			(40-48)	(31-36)	(8-15)	(4-8)	(4-7)
	Average			44.5	34	10.25	6.25	5.25
Site Three	HC1	Silt	0-0.5	50	33	7	6	4
	HC5	Silt	2-2.5	45	39	8	4	4
	HC7	Silt	3-3.5	50	29	9	7	5
	HC11	Silt	5-5.5	48	33	5	7	7
	HC13	Silt	6-6.5	50	33	4	8	5
	HC15	Silt	7-7.5	40	40	9	7	4
	HC18	Silt	8.5-9	48	34	4	9	5
	Range			(40-50)	(29-40)	(4-9)	(4-9)	(4-7)
	Average			47.28	34.42	6.57	6.85	4.85
Site Four	HD1	Sandy silt	0-0.5	49	30	10	5	6
	HD5	Silt	2-2.5	42	33	12	6	7
	HD7	Silt	3-3.5	44	31	13	5	7
	HD15	Muddy sand	7-7.5	44	34	9	5	8
	HD16	Muddy sand	7.5-8	40	39	0	12	9
	HD17	Sandy silt	8-8.5	36	43	13	4	4
	HD18	Sandy silt	8.5-9	38	50	0	6	6
	Range			(36-49)	(30-50)	(0-13)	(4-12)	(4-9)
	Average			41.85	37.14	8.14	6.14	6.71

3.2.2 Clay minerals

Clay is a natural material of very fine texture less than (0.002 mm). Twenty- two samples were attended of both sites 1, 2, 3, and 4 and measured an angle of (2-20)2θ. Kaolinite, illite, montmorillonite, chlorite, palygorskite, mixed layers of montmorillonite-chlorite and illite-palygorskite were most of the clay minerals identified in the sediments of the study area (Fig.4), (Table 6). To understand the genesis of clay minerals by knowledge in-depth geological of a specified environment [3].

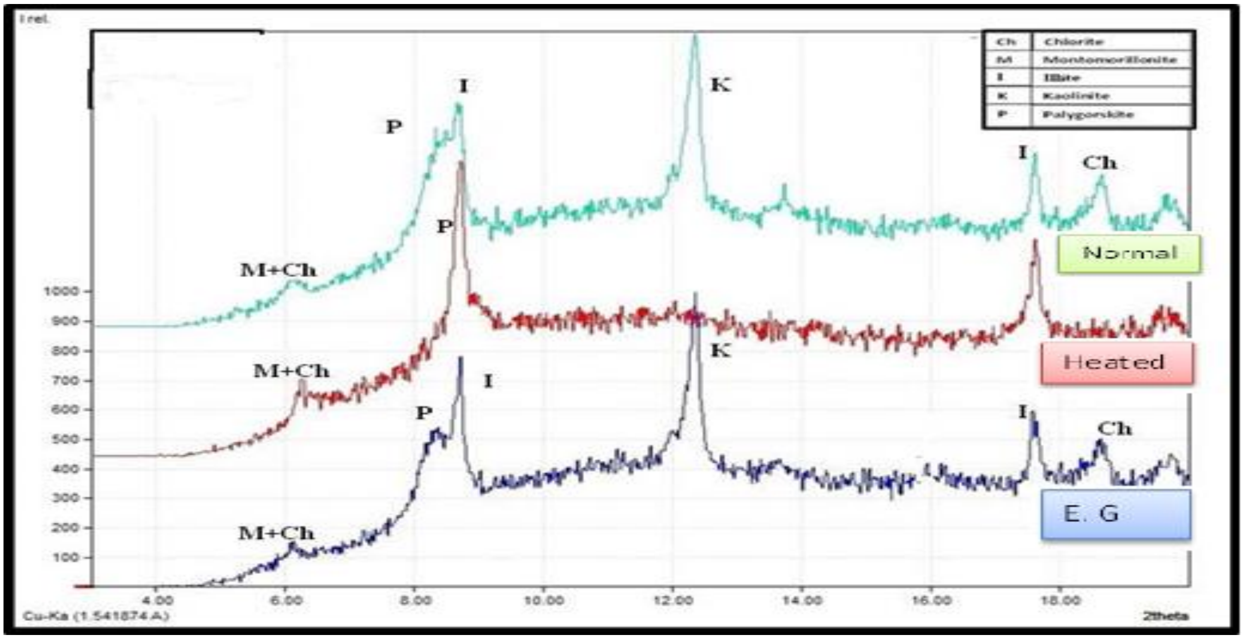

Figure 4: XRD diffractogram of clay minerals.

Table 6: Percentage of clay mineral in south Hammar marsh sites.

Site No.	Sample	Lithology	Depth (m)	K%	I%	M%	Ch%	P%	M-Ch%	P-I%
Site One	HA1	Silt	0-0.5	23	17	24	10	12	10	4
	HA2	Mud	0.5-1	25	23	15	12	9	6	10
	HA3	Mud	1-1.5	23	24	19	13	8	7	6
	HA4	Mud	1.5-2	17	19	23	15	13	8	5
Average				22	20.75	20.25	12.5	10.5	7.75	6.25
Site Two	HB1	Sandy silt	0-0.5	22	13	30	20	6	5	4
	HB2	Sandy silt	0.5-1	30	18	13	35	4	-	-
	HB3	Silt	1-1.5	27	18	10	30	7	8	-
	HB8	Mud	3.5-4	31	16	8	28	5	7	6
Average				27.25	16.25	15.2	28.2	5.5	6.6	5
Site Three	HC1	Silt	0-0.5	25	20	14	16	6	13	6
	HC5	Silt	2.5-5	23	16	17	20	4	9	11
	HC7	Silt	3-3.5	35	24	11	13	-	8	9
	HC11	Silt	5-5.5	25	12	13	18	7	12	13
	HC13	Silt	6-6.5	27	19	10	14	9	9	12
	HC15	Silt	7-7.5	20	16	9	16	12	11	16
	HC18	Silt	8.5-9	33	20	12	17	5	7	6
Average				26.85	18.14	12.28	16.28	7.16	9.85	10.42
Site Four	HD1	Sandy silt	0-0.5	25	16	12	18	6	12	11
	HD5	Silt	2-2.5	32	21	15	13	-	10	9
	HD7	Silt	3-3.5	26	20	18	20	8	9	-
	HD11	Silt	5-5.5	25	22	14	14	9	9	7
	HD16	Muddy sand	7.5-8	26	20	12	12	10	8	12
	HD17	Sandy silt	8-8.5	22	19	10	18	10	7	14
	HD18	Sandy silt	8.5-9	17	15	18	14	22	11	8
Average				24.71	19	14.14	15.57	10.83	9.42	10.16

K= Kaolinite, P= Palygorskite, I= Illite, M- Ch= Montmorillonite- Chlorite mixed layers, M= ontmorillonite
P- I= Palygorskite- Illite mixed layers, Ch= Chlorite

The results obtained for clay minerals diagnosed kaolinite, illite, montmorillonite, chlorite, palygorskite, and the mixed layers montmorillonite - chlorite and palygorskite - illite (Fig. 4 andTable 6). The average of kaolinite mineral varies in sites 1, 2, 3 and 4 between 22%, 27.25%, 26.85%, and 24.71% respectively. The amount of kaolinite is relatively stable along the studied sites, and it increases in small amount with depth in study area, may be due to an increase in the proportion of movable kaolinite. Kaolinite mineral in the sediments had detrital origin because the appropriate conditions to form this mineral in situ are not available in the sediments of study area. The percentage of Illite increases with depth (Table 6); this may be attributed to the leaching of the sediments by the irrigation process or degradation phenomenon in the presence of organic matter. There is a noticeable increase in the percentage of chlorite mineral with depth, especially in sites one and two, chlorite minerals may be formed during weathering of Ferro magnesium rocks that are rich in magnesium, iron.

The mixed-layered minerals present in the studied sites are montmorillionite-chlorite, palygorskite-illite, and noting an increase with depth, especially in sites three and four. This difference may back to the diagenetic processes by illitization and chloritization. By studying the groups of clay minerals in the samples, we can conclude that these groups are derived from many sources and from different locations, and they are minerals in origin and transported by rivers, even by the wind, as a result of the weathering of different rocks, except for the palygorskite mineral, which is likely to be authigenic. The predominant mineral in these sediments is kaolinite, where we notice from Table 6. Illite mineral was in the second place in the study area, while chlorite mineral was in the third place and reflects its composition in an environment characterized by a dry climate.Where [4] showed that Illite is formed in warm climatic conditions and the dominance of physical weathering. As for the minerals montmorillonite and chlorite, they are produced from the weathering of volcanic rocks [5], and their environment is characterized by a dry to semi-arid climate. Palygorskite mineral is found in a percentage ranging from little to medium in Table 6, where its percentage increases in samples are HA1(12%), HC15(12%), HD18(22%) which were characterized by dry arid climatic conditions. This gives evidence that the prevalent sedimentary environmental conditions in the study area were drier. It is possible that there has been transgression in study area. Palygorskite crystallizes in shallow lakes under oxidizing environment [6]. Palygorskite created in the sabkha sediments of central and southern Iraq, resulting from the process of transition of montmorillonite to palygorskite, in the presence of additional amounts of magnesium. Where the sabkha areas in central and southern Iraq are suitable environments characterized by a dry-semi-arid climate with an increase in the amount of evaporation.

The results that were reached in the current study were similar to a certain extent to the results reached by [2]. In their study of the clay minerals in the alluvial sediments, the Hammar marsh sediments, and the mud sediments along the Tigris, Euphrates and Shatt al-Arab basin, and successively, where they found that kaolinite and Illite are the main minerals in these sediments in addition to chlorite and montmorillonite, but the palygorskite was recorded in the current study and in all samples. Can be formed after deposition during the diagenesis process. Twenty- two samples were analyzed for their major oxides (CaO, SiO_2, Al_2O_3, Fe_2O_3, MgO, Na_2O, SO_3, K_2O, TiO_3 and Loss on ignition) (Table 7).

Table 7: Concentrations of major oxides in south Hammar marsh sites.

Site No.	Sample	Lithology	Depth(m)	CaO%	SiO_2%	Al_2O_3%	Fe_2O_3%	MgO%	Na_2O%	SO_3%	K_2O%	TiO_3%	L.O.i%
Site One	HA1	Silt	0-0.5	26.71	42.81	8.95	5.87	4.79	1.55	1.86	2.04	1.66	15.76
	HA2	Mud	0.5-1	27.71	41.91	11.22	6.91	7.1	2.56	1.98	1.89	1.38	18.23
	HA3	Mud	1-1.5	24.22	43.22	10.42	8.44	5.29	2.04	0.89	1.78	1.38	19.27
	HA4	Mud	1.5-2	21.45	45.62	6.76	4.95	3.99	2.03	0.78	1.49	1.22	21.25
Range				21.45-27.71	41.91-45.62	6.76-11.22	4.95-8.44	3.99-7.10	1.55-2.56	0.78-1.98	1.49-2.04	1.22-1.66	15.76-21.25
	Average			25.02	43.39	9.33	6.54	5.29	2.04	1.37	1.8	1.41	18.62
Site Two	HB1	Sandy silt	0-0.5	30.05	40.62	10.55	5.95	4.98	1.45	1.45	1.79	2.01	9.76
	HB2	Sandy silt	0.5-1	26.53	40.33	9.66	7.66	5.93	2.02	1.95	2.05	1.87	10.43
	HB3	Silt	2.5-3	22.76	40.65	9.77	8.55	5.66	2.45	1.5	1.98	1.94	13.56
	HB7	Mud	3-3.5	17.19	40.43	10.57	6.77	3.89	1.85	1.65	0.65	0.94	19.65
Range				17.19-30.05	40.33-40.65	9.66-10.57	5.95-8.55	3.89-5.93	1.45-2.45	1.45-1.95	0.65-2.05	0.94-2.01	9.76-19.65
	Average			24.13	40.5	10.13	7.23	5.11	1.94	1.63	1.61	1.69	13.35
Site Three	HC1	Silt	0-0.5	21.55	45.7	9.78	6.56	5.86	1.99	1.33	1.92	1.1	12.45
	HC5	Silt	2-2.5	18.76	44.43	11.01	7.81	4.76	2.45	0.77	1.5	1.05	13.56
	HC7	Silt	3-3.5	14.92	38.9	11.33	6.17	5.88	1.45	0.78	1.89	0.79	14.77
	HC11	Silt	5-5.5	25.91	42.81	9.77	8.17	5.59	2.02	0.91	2.11	0.96	12.67
	HC13	Silt	6-6.5	28.54	40.54	10.22	6.81	2.55	0.95	1.77	2.07	0.91	19.53
	HC15	Silt	7-7.5	26.71	43.66	8.12	7.14	6.78	2.7	0.75	1.84	0.9	14.77
	HC18	Silt	8.5-9	30.63	37.67	4.55	5.48	4.66	1.88	0.91	0.61	0.38	13.24
Range				14.92-30.63	37.67-45.70	4.55-11.33	5.48-8.17	2.55-6.78	0.95-2.70	0.75-1.77	0.61-2.11	0.38-1.10	12.45-19.53
	Average			23.38	41.95	9.25	6.87	5.15	1.92	1.03	1.71	0.87	14.42
Site Four	HD1	Sandy silt	0-0.5	39.46	30.67	11.26	7.81	6.63	2.23	1.19	1.92	1.1	12.45
	HD5	Silt	2-2.5	22.84	46.1	9.56	6.42	5.96	1.78	0.56	1.5	1.05	13.56
	HD7	Silt	3-3.5	17.67	41.24	10.25	6.61	5.36	1.73	0.56	1.89	0.79	14.77
	HD11	Silt	5-5.5	28.64	46.92	10.81	7.7	6.51	1.86	0.92	2.11	0.96	12.67
	HD13	Muddy sand	6-6.5	30.36	44.65	10.23	7.17	6.37	1.9	0.9	2.07	0.91	19.53
	HD15	Sandy silt	7-7.5	49.53	17.43	9.31	6.84	5.92	2.16	0.92	1.84	0.9	14.77
	HD18	Sandy silt	8.5-9	54.2	12.59	2.87	2.9	3	1.96	2.07	0.61	0.38	13.24
Range				17.67-54.20	12.59-46.92	2.87-11.26	2.90-7.81	3-6.63	1.73-2.23	0.56-2.07	0.61-2.11	0.38-1.10	12.45-19.53
	Average			34.67	34.22	9.18	6.49	5.67	1.94	1.01	1.71	0.87	14.42

The high content of CaO is due to the presence of a high percentage of calcite, which may be related to the presence of shells, especially in the sample HD18 in the fourth position. The high content of CaO, most probable related to deposits of limestone [7]. The presence of silica in the sediments of the study area is in the form of quartz mineral, which has been proven in mineral studies and with the help of X-ray diagrams in addition to the presence of silica within the crystal structure of clay minerals [8]. As [9] suggest that clay minerals are mainly composed of alumina and silica in major amounts and other different mineral matters in low amounts. Alumina is concentrated in sediments of the study area mainly within the structure of clay minerals with the possibility of its adsorption on the surfaces of these minerals as $Al(OH)_2$ aluminum hydroxide, which may exist between plates of montmorillonite and kaolinite minerals. Where the presence of Al_2O_3, SiO_2, and MgO, is related to the abundance of clay minerals [10]. The iron content in the sediments of the sites1, 2, 3, and4 were between 4.95-8.44%, 5.95-8.55%, 5.48-8.17%, and 2.90-7.81% with an average 6.54%,7.23%, 6.87%, and6.49% of sites 1,2,3, and 4 respectively (Table 7), this reflects the oxidation conditions in the sediments of the study area. Magnesium is mainly present in the sediments of the study area within the crystal lattice of the clay minerals. Magnesium is included in the octa hedral position of some clay minerals such as palygorskite and chlorite. As for the montmorillonite mineral, it is done by total replacement of aluminum in these sites and as indicated by [12].

Study area sediments show a remarkable increase in sodium concentrations, reaching between 1.55-2.56%, 1.45-2.45%, 0.95-2.70%, and1.73-2.23 of sites 1,2,3,and 4 respectively (Table 7). Sodium is present in region sediments as a major phase within the structural of clay minerals or as adsorbed to them. Sodium is one of the basic elements included in the crystal network of montmorillonite minerals, may be the possibility of fixing sodium in clay minerals by means of ionic substitution with potassium. The range of SO_3 in study area is between 0.78-1.98%, 1.45-1.95%, 0.75-1.77%, and 0.56-2.07% of sites 1, 2, 3, and 4 respectively (Table 7). The presence of sulfates in the study area is associated with the presence of sulfate minerals such as gypsum, which was proven to be present in the mineral study. Where the proportion of gypsum mineral in the samples HB3, HC11, HD5, HD7, HD15, and HD16 was high and this gives evidence that the environment was drier. The concentration of K_2O reached between1.49-2.04%, 0.65-2.05%, 0.61-2.11%, and 0.61-2.11% (Table 7) of sites 1, 2, 3, and 4 respectively (Table 7). The presence of potassium is associated with clay minerals, especially in the mineral illite, whose presence was proven during the mineral study, where potassium enters as an essential element between the Illite sheets and works to link these plates among themselves.

The concentration of titanium in the samples ranged between 1.22-1.66%, 0.94-2.01%, 0.38-1.10%, and 0.38-1.10% of sites 1, 2, 3, and 4 respectively (Table 7). TiO_2 is abundant in clay minerals especially in montmorillonite and kaolinite minerals, where Ti is absorbed on kaolinite. Titanium is concentrated in fine particles, as its concentration increases as the size of the particles decreases due to the increase in the surface area. The oxides; Silica, calcium oxide, aluminum, magnesium and iron were considered basic components, while the oxides - alkali potassium, sodium, titanium oxide and sulfate were secondary components in lower

Mesopotamia. Loss on ignition includes all the losses by ignition of $CaCO_3$, organic matter and evaporates (F, Cl), in addition, part of the losses by ignition are due to the water present in its various forms (H_2O^-, H_2O^+) in the clay minerals. The amount of unburned carbon in the sediment represents Loss on ignition [8].Loss on ignition content in site one ranged between 15.76-21.25%with an average 18.62%, while site two is from 9.76-19.65% with an average 13.35% , site three 12.45-19.53% with an average 14.42% and for site four is from 12.45-19.53% with an average 14.42% (Table 7).

4. Conclusions

The grain size analysis showed the predominance of silt in the study area. Study area sediments were classified as soft sediments mainly represented by Silt, Sandy silt, Mud, and Muddy sand. The environment affecting the sediments of study area is the calm environment. The sediments were derived, was characterized by the predominance of mechanical weathering processes and that the climate of the region was dry to semi-arid. The diversity of the source rocks in the sediments of study area due to the great variation in clay and non- clay minerals. The presence of Palygorskite mineral in a high percentage in different depths of the study area gives evidence that the prevailing sedimentary environment conditions were drier. The increase in the concentration of magnesium (MgO) in the sediments is related to the abundance of the mineral Palygorskite. Most of the main elements in the sediments of study area, represented by (SiO_2, Al_2O_3, Fe_2O_3, MgO, Na_2O, and K_2O) were found in a main phase within the crystal lattice of clay minerals.

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دراسة معدنية وجيوكيميائية لرواسب اسفل بلاد ما بين النهرين ,جنوب العراق

خليل جبارالسوداني [1] ، بدر نعمة البدران [2] ، ليفيو جيوسان [3]

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المستخلص

تستند هذه الدراسة إلى ثمانية وأربعين عينة تم جمعها من مواقع مختارة في أسفل بلاد ما بين النهرين. يتراوح عمق أخذ العينات ما بين 1 و 9 أمتار ضمن جنوب هور الحمار للجزء الجنوبي من أسفل بلاد ما بين النهرين. يشير توزيع الحجم الحبيبي إلى أن الرواسب تتكون أساسًا من الغرين مع كمية قليلة من الطين والرمل ، ومعظم قوام الرواسب المدروسة يتميز بالغرين والغرين الرملي والوحل والرمل الوحلي. المعادن غير الطينية السائدة هي Calcite وQuartz وDolomite و Feldspar وGypsum بينما تتكون المعادن الطينية من : Kaolinite و Illite و Montmorillonite و Chlorite و Palygorskite والطبقات المختلطة Chlorite - Montmorillonite و Palygorskite - Illite. أظهر التحليل الكيميائي أن جميع العينات لديها تركيز عالٍ في SiO_2 و CaO مقارنة مع Al_2O_3 و Fe_2O_3 و MgO و SO_3 و K_2O و Na_2O. ترتبط هذه النتائج عمومًا بتكوين المعادن الطينية. ربما تتميز البيئة الترسيبية لهذه المعادن بمناخ جاف إلى شبه جاف في منطقة المصدر.