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Research Article

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Indices of Exchangeable Heavy Metals Pollution in Shatt Al-Arab Estuary – Part 1

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Abstract This work was carried out to monitoring of Shatt Al-Arab river pollution by assessing the degree of exchangeableheavy metals pollution (Pb, Ni, Cu, Cr, Zn, Co, Cd and Fe) in the sediment samples by using Flame Atomic Absorption Spectrophotometer (FAAS) for sediment core at six stations along Shatt Al-Arab estuary they are: (Al-Qurna, Al-Deer, Al-Qarma, Al-Ashar, Abu-Alkasib and Al-Fao). The degree of Pollution in the sediments had been evaluated by using Contamination factor (CF), Enrichment factor (EF), Geo accumulation index (I-geo), pollution load index (PLI), dna Anthropogenic Factor (AF).

Keywords Heavy metals, Exchangeable, sediment core, Shatt AL-Arab estuary

Introduction

Heavy Metal is an imprecise term generally taken to include the metallic Metals with an atomic weight greater than 40, which have specific gravity greater than 5 g/cm^3. The investigation in Heavy metals pollution is very important in Basrah city due to petroleum production and other activities in this region. The industrial effluents (liquids or solids) that are discharged to the surface or sea waters are the main reason behind water pollution. The control of such pollution problems in the aquatic environment is very difficult because of the large number of input sources and their geographic dispersions. Sediments constitute a good record, and were be about the today's' state and the history of contaminated area, they can provide an integrated picture about the events that occurred in the water column [1,2]. The assessment of sediment enrichment with elements can be carried out in many ways. The most common ones are the index of geo-accumulation index (I-geo), pollution load index (PLI) Enrichment factor (EF), Anthropogenic Factor (AF) and Contamination factor (CF) .

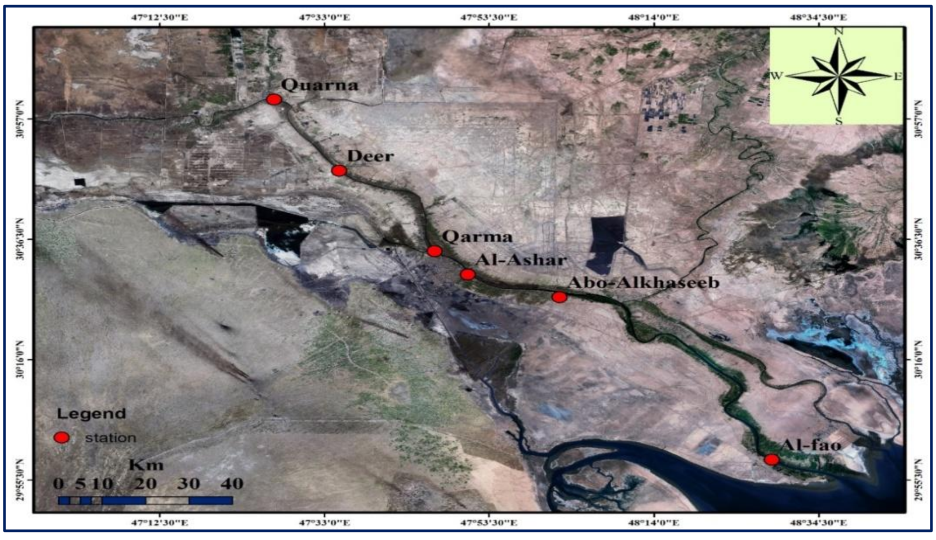

Figure 1: The study stations

Materials and Methods

The research method followed collecting sediment samples from six sampling stations which represent different sector of Shatt Al-Arab estuary for analysis and estimation the pollution of exchangeable heavy Metals (Cr, Co, Cd, Cu, Pb, Ni, Fe and Zn) in these sediment cores. GPS instrument is used to fix the positions of these stations. They are: Al-Deer, Al-Qarma, Al-Qurna, Al-Ashar, Abo-Alkasib and Al-Fao as shown in Fig (1).

Sediment cores (Acid washed PVC pipe of 1m lengthX10 cm diameter) were collected from six stations. The cores were inserted into the water-sediment interface and pushed to ensure that it reached maximum depth. The cores were slowly retrieved back, closed with its cover immediately and marked as to which is the upward direction .

The exchangeable heavy metals ions were extracted from sediment according to the method of [3]

-Determination of Contamination Factor (CF)

Contamination Factor was used to determine the contamination status of sediment in the current study. CF was calculated according to the equation described below:

$$CF = Mc / Bc$$

Where Mc Measured concentration of the metal and Bc is the background concentration of the same metal. Four contamination categories are documented on the basis of the contamination factor [4].

Table 1: Classification [4]

CF	Contamination Factor Indicate
CF<1	low contamination
1≤CF≤ 3	moderate contamination
3≤CF<6	considerable contamination
CF>6	very high contamination

-Determination of Enrichment Factor (EF)

To evaluate the magnitude of source material found in the Earth's crust [5], the following equation was used to calculate the EFC as contaminants in the environment, the enrichment factors (EF) were computed relative to the abundance of species as proposed by [6].

$$EF = (CM / CFe)_{sample} / (CM / CFe)_{Earth's\ crust}$$

Were, (CM / CFe) sample is the ratio of concentration of trace metal (CM) to that of Fe (CFe) in the sediment sample; (CM / CFe) Earth's crust is the same reference ratio in the Earth's crust; the reference value of Fe is 5.2% was selected as the reference element, due to its crustal dominance and its high immobility [5].

Table 2: Classification [5]

EF	Enrichment Factor Indicates
EF <1	no enrichment
EF <3	minor enrichment
EF = 3-5	moderate enrichment
EF = 5-10	moderate to severe enrichment
EF = 10-2	severe enrichment
EF 25-50	very severe enrichment
EF >50	extremely severe enrichment

-Determination of Geo Accumulation Index (Igeo)

The geo accumulation index I*geo* values were calculated for different metals, as introduced by [7] as follows:

$$I\text{-}geo = log_2 (Cn / 1.5\ Bn)$$

Where, Cn: is the measured concentration of element n in the sediment; Bn: is the geo accumulation background for the element n which is either directly measured in precivilization sediments of the area or taken from the literature average shale value, described by [8].

Table 3: Classification [7]

Igeo	Sediments Pollution Case
<0	practically unpolluted- Background sample
1-2	unpolluted to moderately polluted
2-3	moderately polluted to polluted
3-4	strongly polluted
4-5	strongly to extremely polluted
>5	extremely polluted

-Pollution Load Index (PLI)

[9] had employed a simple method based on pollution load index to assess the extent of pollution by metals in estuarine sediments. Sediment pollution load index was calculated using the equation:

$$CF = C_{metal} / C_{background}$$

$$PLI = \sqrt[n]{(CF1 \times CF2 \times CF3 \times \ldots\ldots CFn)}$$

Where, CF is the contamination factor, C_{metal} is the concentration of pollutant in sediment $C_{background}$ is the background value for the metal n is the number of metals.

Table 4: Classification [9]

PLI	Indicates
value > 1	polluted
Whereas < 1	no pollution

-Anthropogenic Factor (AF)

In order to evaluate the data in detail, the anthropogenic factors of elements in the cores were calculated according to [10] the following formula:

$$AF = C_s/C_d$$

Where, C_s and C_d refer to the concentrations of the elements in the surface sediments and at depth in sediment column.

Table 5: Classification [11]

AF	Indicates
>1 for a particular metal	contamination exists
≤1	is no metal enrichment of anthropogenic origin.

Results and Discussion

Vertical distribution of the exchangeable heavy metals ions is shown in table (6) to (11).

Table 6: Concentration of Exchangeable Heavy Metals (μg/g) dry weight in sediment core from Al-Qurna station

Depth cm	pb	Ni	Cu	Cr	Zn	Co	Cd	Fe
0-5	35.54	60.55	20.72	60.71	40.32	10.96	10.76	3850.65
5-10	33.92	58.63	19.65	58.54	39.95	10.81	10.34	2538.61
15-20	33.62	53.79	19.27	58.35	37.19	10.45	10.02	2485.21
20-25	33.45	47.65	19.19	54.92	35.71	10.35	8.65	2238.42
25-30	31.24	47.35	15.55	54.31	33.44	10.11	8.49	2077.83
30-35	30.72	38.72	12.48	52.62	31.42	9.89	7.62	2126.4
35-40	29.41	38.14	12.12	52.16	29.61	9.75	7.16	1562.73
40-45	29.63	32.23	11.84	51.74	27.63	9.43	7.04	1369.61
45-45	29.33	30.77	10.22	51.13	26.72	9.28	5.61	1065.92
45-50	29.29	30.54	10.06	51.05	25.63	8.79	5.01	950.78
Total	316.15	438.37	151.1	545.53	327.62	99.82	80.7	20266.16
Mean	31.62	43.84	15.11	54.55	32.76	9.98	8.07	2026.62

Table 7: Concentration of Exchangeable Heavy Metals (µg/g) dry weight in sediment core from Al- Deer

Depth cm	pb	Ni	Cu	Cr	Zn	Co	Cd	Fe
0-5	37.24	62.48	20.68	60.24	41.09	11.98	10.95	2856.11
5-10	36.48	60.03	19.79	59.93	40.5	11.9	10.56	2651.61
10-15	36.17	57.21	19.75	59.33	39.91	10.88	9.28	2427.42
15-20	30.89	53.23	15.3	56.84	39.66	10.48	9.14	2279.75
20-25	30.75	50.26	15.09	56.13	39.33	8.59	9.22	2686.18
25-30	30.3	44.37	12.75	54.96	30.94	8.04	8.11	1489.59
30-35	29.17	44.13	12.31	54.8	30.66	7.92	8.04	1225.15
35-40	25.72	35.78	12.83	51.91	29.04	6.27	7.3	1175.09
40-45	23.89	35.37	11.73	51.41	27.61	6.16	6.16	1952.68
45-50	20.15	30.75	9.17	50.88	26.25	4.46	6.05	1685.81
Total	300.76	473.61	149.4	556.43	344.99	86.68	84.81	20429.39
Mean	30.076	47.361	14.94	55.64	34.50	8.67	8.481	2042.94

Table 8: Concentration of Exchangeable of Heavy Metals (µg/g) dry weight in sediment core from Al- Qarma

Depth cm	Pb	Ni	Cu	Cr	Zn	Co	Cd	Fe
0-5	31.72	63.93	24.51	63.91	43.17	14.87	13.32	4987.92
5-10	30.49	58.13	23.35	62.96	41.17	14.23	13.14	4598.19
10-15	30.27	55.14	23.22	61.9	39.56	13.43	12.11	4568.18
15-20	29.71	52.9	22.35	59.26	37.55	12.87	12.04	4357.16
20-25	28.27	46.57	21.65	58.28	36.11	12.12	11.26	4248.49
25-30	27.51	42.75	21.22	56.02	35.06	11.8	11.16	4149.66
30-35	27.34	37.95	19.34	55.02	31.91	11.21	10.73	4024.76
35-40	26.53	34.2	18.77	53.19	27.82	10.83	10.36	3951.27
40-45	25.61	33.4	17.61	52.19	25.05	10.82	9.58	3482.92
45-50	25.47	32.48	15.02	51.89	23.34	9.49	8.33	3329.33
Total	282.92	457.45	207.04	574.62	340.74	121.67	112.03	41697.88
Mean	28.29	45.75	20.70	57.46	34.07	12.17	11.20	4169.79

Table 9: Concentration of Exchangeable of Heavy Metals (µg/g) dry weight in sediment core from Al-Ashar

Depth cm	pb	Ni	Cu	Cr	Zn	Co	Cd	Fe
0-5	37.54	63.88	23.11	64.26	43.1	15.85	11.92	3425.15
5-10	36.92	63.55	22.76	64.01	42.75	14.87	11.44	3256.26
10-15	36.65	63.05	22.2	63.53	42.5	14.82	10.19	3121.59
15-20	36.46	59.78	20.32	60.71	40.27	14.58	11.75	3085.23
20-25	31.92	52.77	19.79	60.13	40.19	13.28	11.61	2925.31
25-30	31.72	52.53	19.23	59.13	35.4	11.52	10.45	2895.1
30-35	31.52	46.88	19.06	58.1	35.24	11.26	9.63	2852.16
35-40	30.64	46.26	18.45	58.48	30.82	10.35	9.27	2554.23
40-45	28.2	37.53	18.54	58.08	30.67	10.25	9.11	2212.24
45-50	28.11	30.07	14.12	54.22	25.39	7.92	7.49	1025.18
Total	329.68	516.3	197.58	600.65	366.33	124.7	102.86	27352.45
Mean	32.97	51.63	19.76	60.07	36.63	12.47	10.29	2735.25

Table 10: Concentration of Exchangeable of Heavy Metals (µg /g) dry weight in sediment core from Abu-Alkasib

Depth cm	Pb	Ni	Cu	Cr	Zn	Co	Cd	Fe
0-5	32.3	61.53	26.49	65.01	42.94	12.74	11.48	4261.56
5-10	31.63	61.21	26.11	64.49	41.92	12.15	11.32	4125.47
10-15	31.54	60.14	24.85	61.24	39.53	11.4	10.95	3987.18
15-20	31.23	55.97	24.4	60.24	30.14	11.14	10.75	3562.66
20-25	29.71	55.88	21.03	58.91	30.07	10.18	9.29	3485.87

25-30	29.37	50.87	20.57	58.54	28.97	10.04	9.15	3258.59
30-35	28.24	50.39	16.26	58.2	28.28	9.25	8.61	3025.28
35-40	24.92	48.23	16.88	54.91	26.82	8.87	8.21	2836.3
40-45	24.11	42.23	13.01	54.5	26.78	8.55	5.42	2551.25
45-50	21.61	40.07	10.61	51.39	23.41	8.25	5.22	2245.68
Total	284.66	526.52	200.21	587.43	318.86	102.57	90.4	33339.84
Mean	28.47	52.65	20.02	58.74	31.89	10.26	9.04	3333.98

Table 11: Concentration of Exchangeable Heavy Metals (µg /g) dry weight in sediment core from Al-Fao station

Depth cm	pb	Ni	Cu	Cr	Zn	Co	Cd	Fe
0-5	31.72	65.93	22.51	65.91	41.17	13.95	12.06	4261.66
5-10	30.71	54.13	21.18	64.15	40.16	12.17	11.75	4125.66
10-15	30.27	50.94	20.42	60.9	39.56	11.93	11.33	3562.27
15-20	30.23	50.6	20.35	60.26	39.55	11.27	10.64	3250.92
20-25	28.97	51.57	18.65	60.28	39.11	11.12	10.31	3211.33
25-30	28.51	48.75	18.22	59.52	36.96	10.8	10.25	3200.83
30-35	27.34	41.2	17.84	58.92	36.81	10.21	10.06	2835.92
35-40	26.53	46.4	17.77	58.19	32.82	9.83	8.16	2751.19
40-45	26.11	36.48	14.61	53.19	32.05	8.22	9.78	2635.18
45-50	25.47	33.65	13.02	51.89	25.34	8.49	9.76	2567.19
Total	285.86	479.65	184.57	593.21	363.53	107.99	104.1	32402.15
Mean	28.59	47.97	18.46	59.32	36.35	10.80	10.41	3240.22

-Contamination Factor (CF) In Exchangeable Heavy Metals in Sediment Core of Study Stations

From the results we found that the Contamination Factor (CF) of metals inversely proportional with the depth for all stations except the iron metal in Al-Deer station**.**

Lead (Pb): The highest value of Contamination Factor (CF) of lead was (2.68) at (0-5 cm) depth in Al-Ashar station and the lowest value was (1.44) at (45-50 cm) depth in Al-Deer station. According to Table (1), the CF value for Pb are (1≤CF≤ 3), indicating that this environment were moderate contamination.

Nickel (Ni): The highest value of Contamination Factor (CF) of Nickel in the exchangeable phase was (0.78) at (0-5 cm) depth in Al-Fao station and the lowest value was (0.36) at (45-50 cm) depth in Al-Ashar station and Al-Qurna station. According to Table (1), the CF value for Ni are (CF<1), indicating that this environment were low contamination.

Copper (Cu): The highest value of Contamination Factor (CF)of Copper in the exchangeable phase was (0.44) at (0-10 cm) depth in Abu-Alkasib station and the lowest value was (0.15) at (45-50 cm) depth in Al-Deer station. According to Table (1), the CF value for Cu are (CF<1), indicating that this environment were low contamination.

Chrome (Cr): the highest value of Contamination Factor (CF)of Chrome in the exchangeable phase was (0.65) at (0-5 cm) depth in Al-Fao station and the lowest value was (0.50) at (45-50 cm) depth in Al-Qurna station, Al-Deer station, and Abu-Alkasib station.

According to Table (1), the CF value for Cr are (CF<1), indicating that this environment were low contamination.

Zinc (Zn): the highest value of Contamination Factor (CF)of Zinc in the exchangeable phase was (0.62) at (0-5 cm) depth in Al-Qarma station and Al-Ashar station, and the lowest value was (0.33) at (45-50 cm) depth in Al-Qarma station and Abu-Alkasib station.According to Table (1), the CF value for Zn are (CF<1), indicating that this environment were low contamination.

Cobalt (Co): The highest value of Contamination Factor (CF) of Cobalt in the exchangeable phase was (0.63) at (0-5 cm) depth in Al-Ashar station and the lowest value was (0.18) at (45-50 cm) depth in Al-Deer station. According to Table (1), the CF value for Co are (CF<1), indicating that this environment were low contamination.

Cadmium (Cd): The highest value of Contamination Factor (CF) of Cadmium in the exchangeable phase was (88.80) at (0-5 cm) depth in Al-Qarma station and the lowest value was (33.40) at (45-50 cm) depth in Al-Qurna station. According to Table (1), the CF value for Cd are (CF>6), indicating that this environment were very high contamination.

Iron (Fe): The highest value of Contamination Factor(CF)of Iron inthe exchangeable phase was (0.09) at (0-10 cm) depth in Al-Qarma station and the lowest value was (0.02) at (35-50 cm) depth in Al-Qurna station, at (30-40) in Al-Deer station and at (45-50) Al-Ashar station.According to Table (1), the CF value for Fe are (CF<1), indicating thatthis environment were low contamination.

-Pollution Load Index (PLI) in Exchangeable Heavy Metals in Sediment Core of Study Stations

The Pollution Load Index (PLI) of exchangeable Heavy Metalsinverselyproportional with the depth for all stations, whereas the highest value of Pollution Load Index (PLI) in the exchangeable phase was (1.48) at (0-5 cm) depth in Al-Ashar station and the lowest value was (0.73) at (45-50 cm) depth in Al-Deer station.

According to Table (4), the PLI value for study stations are (value>1),indicating that this environment were polluted However, Al-Ashar station displayed the highest PLI value and reflects the highest presence of all the introspected heavy metals, indicating that this site is considerably affected by different anthropogenic activities.

- Enrichment Factor (EF) of ExchangeableHeavy Metals in Sediment Core of Study Stations

From the results we found:

Lead (Pb): The highest value of Enrichment Factor (EF) of lead in the exchangeable phase was (123.89) at (45-50 cm) depth in Al-Qurna station and the lowest value was (25.57) at (0-5 cm) depth in Al-Qarma station. According to Table (2), the EF value for Pb are (EF= 25-50) to (EF >50), indicating that this environment were very severe enrichment to extremely severe enrichment .

Nickel (Ni): The highest value of Enrichment Factor (EF) of Nickel in the exchangeable phase was (24.14) at (30-35 cm) depth in Al-Deer station and the lowest value was (6.32) at (30-35 cm) depth in Al-Qarma station.According to Table (2), the EF value for Ni are (EF = 5-10) to (EF=10-25), indicating that this environment were (moderate to severe enrichment) to (severe enrichment).

Copper (Cu): The highest value of Enrichment Factor (EF)of Copper in the exchangeable phase was (12.92) at (45-50 cm) depth in Al-Ashar station and the lowest value was (0.31) at (45-50 cm) depth in Al-armaQ station. According to Table (2), the EF value for Cu are (EF <1) to (EF =10-25), indicating that this environment were no enrichment to severe enrichment.

Chrome (Cr): The highest value of Enrichment Factor (EF) of Chrome in the exchangeable phase was (29.64) at (45-50 cm) depth in Al-Qurna station and the lowest value was (7.07) at (0-5cm) depth in Al- Qarma station. According to Table (2), the EF value for Cr are (EF = 5-10) to (EF= 25-50),indicating that this environment were moderate to severe enrichment to very severe enrichment.

Zinc (Zn): The highest value of Enrichment Factor (EF) of Zinc in the exchangeable phase was (21.68) at (45-50cm) depth in Al-Qurna station, and the lowest value was (5.64) at (45-50 cm) depth in Al-Qarma station. According to Table (2), the EF value for Zn are (EF = 5-10) to (EF = 10-25), indicatingthat this environment were moderate to severe enrichment to severe enrichment.

Cobalt (Co): The highest value of Enrichment Factor (EF) of Cobalt in the exchangeable phase was (20.82) at (45-50 cm) depth in Al-Qurna station, and the lowest value was (5.96) at (45-50 cm) depth in Al-Deer station.According to Table (2), the EF value for Co are (EF = 5-10) to (EF = 10-25), indicating that this environment were moderate to severe enrichment to severe enrichment.

Cadmium (Cd): The highest value of Enrichment Factor (EF) of Cadmium in the exchangeable phase was (2742.20) at (45-50 cm) depth in Al-Ashar station and the lowest value was (797.38) at (40-45 cm) depth in Abu-Alkasib station. According to Table (2), the EF value for Cd are (EF >50), indicating that this environment were extremely severe enrichment.

-Geo accumulation Index (I-geo) in Exchangeable Heavy Metals in Sediment Core of Study stations.

From the results we found:

Lead (Pb): the highest value of Geo accumulation Index (I-geo) of lead in the exchangeable phase was (0.82) at (0-5 cm) depth in Al-Ashar station and the lowest value was (-0.06) at (45-50 cm) depth in Al-Deer station.

According to Table (3), the I-geo value for Pb are (I-geo<0), indicating that this environment were practically unpolluted.

Nickel (Ni): the highest value of Geoaccumulation Index (I-geo) of Nickel in the exchangeable phase was (-0.93) at (0-5 cm) depth in Al-Fao station and the lowest value was (-2.67) at (45-50 cm) depth in Al-Ashar station. According to Table (3), the I-geo value for Ni are (I-geo<0), indicatingthat this environment were practically unpolluted.

Copper (Cu): the highest value of Geoaccumulation Index (I-geo) of Copper in the exchangeable phase was (-1.76) at (0-5 cm) depth in Abu-Alkasib station and the lowest value was (-3.29) at (45-50 cm) depth in Al-Deer station. According to Table (3), the I-geo value for Cu are (I-geo<0), indicating that this environment were practically unpolluted.

Chrome (Cr): The highest value of Geoaccumulation Index (I-geo) of Chrome in the exchangeable phase was (-1.21) at (0-5 cm) depth in Al-Fao station and the lowest value was (-1.59) at (45-50 cm) depth in Al-Deer station. According to Table (3), the I-geo value for Cr are (I-geo<0),indicating that this environment were practically unpolluted.

Zinc (Zn): The highest value of Geoaccumulation Index (I-geo) of Zinc in the exchangeable phase was (-1.28) at (0-5 cm) depth in Al-Qarma station and Al-Ashar station, and the lowest value was (-2.17) at (45-50 cm) depth in Al-Qarma station and Abu-Alkasib station.According to Table (3), the I-geo value for Cu are (I-geo<0), indicating that this environment were practically unpolluted.

Cobalt (Co): The highest value of Geoaccumulation Index (I-geo) of Cobalt in the exchangeable phase was (-1.24) at (0-5 cm) depth in Al-Ashar station and the lowest value was (-3.07) at (45-50 cm) depth in Al-Deer station. According to Table (3), the I-geo value for Co are (I-geo<0),indicating that this environment were practically unpolluted.

Cadmium (Cd): The highest value of Geoaccumulation Index (I-geo) of Cadmium in theexchangeable phase was (5.89) at (0-5 cm) depth in Al-Qarma station and the lowest value was (4.48) at (45-50 cm) depth in Al-Qurna station. According to Table (3), the I-geo value for Cd are (I-geo=4-5) to (I-geo >5),indicatingthat this environment were strongly to extremely polluted to extremely polluted.

Iron (Fe): The highest value of Geoaccumulation Index (I-geo) of Iron inthe exchangeable phase was (-4.08) at (0-5 cm) depth in Al-Qarma station and the lowest value was (-6.47) at (45-50 cm) depth in Al-Qurna station. According to Table (3), the I-geo value for Fe are (I-geo<0), indicating that this environment were practically unpolluted.

- Anthropogenic Factor (AF) in Exchangeable Heavy Metals in Sediment Core of Study Stations.

From the results we found**:**

Lead (Pb): The highest value of Anthropogenic Factor(AF)of lead in the exchangeable phase was (1.85) at (45-50 cm) depth in Al-Deer station and the lowest value was (1.02) at (5-10cm) depth in Al-Deer station, Al-Ashar station and Abu-Alkasib station.According to Table (5), the AF value for Pb are (AF>1 for a particular metal), indicating that this environment have anthropogenic input and the contamination exists.

Nickel (Ni): The highest value of Anthropogenic Factor (AF)of Nickel in the exchangeable phase was (2.12) at (45-50 cm) depth in Al-Ashar station and the lowest value was(1.01) at (5-10cm) depth in Al-Ashar station and Abu-Alkasib station. According to Table (5), the AF value for Ni are (AF>1 for a particular metal), indicating that this environment have anthropogenic input and the contamination exists.

Copper (Cu): The highest value of Anthropogenic Factor (AF)of Copper in the exchangeable phase was (2.50) at (45-50 cm) depth in Abu-Alkasib station and the lowest value was(1.01) at (5-10cm) depth in Abu-Alkasib station.According to Table (5), the AF value for Cu are (AF>1 for a particular metal), indicating that this environment have anthropogenic input and the contamination exists.

Chrome (Cr): Tthe highest value of Anthropogenic Factor (AF)of Chrome in the exchangeable phase was (1.27) at (45-50 cm) depth inAbu-Alkasib station and Al-Fao station and the lowest value was(1.00) at (5-10cm) depth in Al-Ashar station.According to Table (5), the AF value for Cr are (AF>1 for aparticular metal), indicating that this environment have anthropogenic input and the contamination exists in all stations accept in Al-Ashar station at (5-10cm) depth (AF=1.00),indicating that this environment have no metal enrichment of anthropogenic origin.

Zinc (Zn): The highest value of Anthropogenic Factor (AF)of Zinc in the exchangeable phase was (1.85) at (45-50 cm) depth in Al-Qarmastation, and the lowest value was(1.01) at (5-10cm) depth in Al-Qurna station, Al-Deer station and Al-Ashar station**.** According to Table (5), the AF value for Zn are (AF>1 for a particular metal), indicating that this environment have anthropogenic input and the contamination exists.

Cobalt (Co): The highest value of Anthropogenic Factor (AF) of Cobalt in the exchangeable phase was (2.69) at (45-50cm) depth in Al-Deer station and the lowest value was(1.01) at (5-10cm) depth in Al-Qurna station and Al-Deer station.According to Table (5), the AF value for Co are (AF>1 for aparticular metal), indicating that this environment have anthropogenic input and the contamination exists.

Cadmium (Cd): The highest value of Anthropogenic Factor (AF)of Cadmium in the exchangeable phase was (2.20) at (45-50 cm) depth in Abu-Alkasib station and the lowest value was(1.01) at (5-10cm) depth in Al-Qarma station and Abu-Alkasib station .According to Table (5), the AF value for Cd are (AF>1 for a particularmetal),indicatingthat this environment have anthropogenic input and the contamination exists.

Iron (Fe): The highest value of Anthropogenic Factor (AF)of Iron inthe exchangeable phase was (4.05) at (45-50cm) depth in Al-Qurna station and the lowest value was(1.03) at (0-5cm) depth in Abu-Alkasib station and Al-Fao station. According to Table (5), the AF value for Fe are (AF>1 for a particularmetal), indicating that thisenvironment have anthropogenic input and the contamination exists.

Conclusion

- The results obtained for the sediment samples concentrations were high except for Cd and Co which were relatively low. They were followed in order as: Fe > Cr > Ni > Zn >Pb>Cu > Co > Cd.
- Higher concentrations of some heavy metals in the sediments indicate that the sediments acted as a sink and source for these metals.
- The study has found that there is inversely proportional between the concentrations of heavy metals and the depth for all stations except the Nickel in Al-Deer station in the exchangeable phase.

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