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Research Article

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Indices of Residual Heavy Metals Pollution in Shatt AL-Arab Estuary – Part 2

Zahra'a S. R. Al-Shamsi[1], Abbas H. Mohammed[1], Hamid T. Al-Saad[2]

[1]College of Science, Department of Geology, University of Basrah, Basrah, Iraq
[2]College of Marine Science, University of Basrah, Iraq

Abstract This study was carried out to monitoring of Shatt Al-Arab river pollution by assessing the degree of residual heavy 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, Residual, sediment core, Shatt Al-Arab estuary

Introduction

Within rapid industrialization and economic development in coastal areas around the world heavy metals are introduced to the coastal environment [1,2]. Heavy metals are transported as either dissolve species in water or in association with suspended sediments and are subsequently deposited and stored in bottom sediments. After burial some the distribution of some redox sensitive metal could be modified by natural processes in the sediment. The bioaccumulation of heavy metals in coastal sediments can be hazardous to the local population which uses the coast area for fishing activity [3,4]. Heavy metals may distribute in sediments as exchangeable, acid soluble (bound to carbonates), reducible (bound to Fe/Mn oxides and hydroxides), oxidizable (bound to organic matter) and residual (bound to silicates and detrital materials) species. The chemical fractionation of heavy metals in sediments can be investigated by carefully employing a selective extraction scheme from the several extraction schemes available in the literature [5]. 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) .

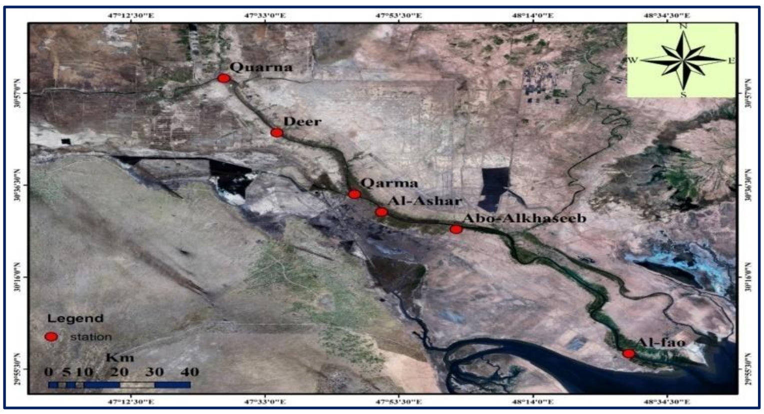

Figure 1: The study stations

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 residual heavy Metals (Zn, Co, Cd, Cu, Ni, Pb, Fe and Cr) 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 residual heavy metals ions were extracted from sediment according to the method of [6].

-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 [7].

Table 1: Classification [7]

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 [8], 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 [9].

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

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 [8].

Table 2: Classification [8]

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 [10] 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 [11].

Table 3: Classification [10]

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)

[12] 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 [12]

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 [13] 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 [14]

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

Results and Discussion

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

Table 6: Concentration of Residual 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	71.54	85.42	45.15	99.98	62.01	15.09	15.95	2785.99
5-10	70.77	82.55	44.39	94.59	61.94	14.87	15.64	2531.01
15-20	67.11	79.83	34.47	88.56	60.1	14.36	14.35	2152.17
20-25	62.31	77.11	30.3	81.25	58.39	12.63	14.27	1598.45
25-30	55.57	75.24	29.29	73.91	57.87	12.39	13.62	1254.71
30-35	52.33	75.13	29.19	70.34	57.47	12.1	13.27	1875.22
35-40	44.24	75.08	27.35	60.49	57.15	10.42	13.22	1957.52
40-45	32.56	66.85	21.71	60.23	55.7	10.16	12.22	1584.56
45-45	30.87	66.47	21.22	58.77	55.11	10.07	12.15	1632.71
45-50	25.61	65.3	20.29	55.11	50.74	8.3	9.05	1284.88
Total	512.91	748.98	303.36	743.23	576.48	120.39	133.74	18657.22
Mean	51.29	74.90	30.34	74.32	57.65	12.04	13.37	1865.72

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

Depth (cm)	pb	Ni	Cu	Cr	Zn	Co	Cd	Fe
0-5	**70.33**	**80.97**	**40.65**	**100.37**	**60.81**	**18.82**	**12.81**	**5120.25**
5-10	**68.34**	**78.46**	**39.77**	**98.28**	**60.31**	**18.05**	**12.64**	**4356.29**
15-20	**68.71**	**74.91**	**37.64**	**98.03**	**58.62**	**17.61**	**12.11**	**3635.62**
20-25	**57.92**	**71.7**	**31.64**	**82.61**	**58.48**	**17.22**	**11.37**	**3599.32**
25-30	**57.26**	**69.63**	**31.24**	**82.24**	**58.12**	**17.03**	**11.06**	**3226.62**
30-35	**50.27**	**67.31**	**26.42**	**72.63**	**53.24**	**16.73**	**9.52**	**3231.27**
35-40	**44.92**	**66.92**	**22.61**	**72.32**	**51.61**	**16.32**	**9.32**	**2619.63**
40-45	**41.62**	**62.76**	**22.52**	**68.67**	**51.16**	**12.24**	**9.15**	**1923.62**
45-45	**41.31**	**62.39**	**22.02**	**63.64**	**51**	**12.11**	**9.07**	**1692.43**
45-50	**40.66**	**62.33**	**20.77**	**60.18**	**50.03**	**10.37**	**8.24**	**1670.42**
Total	**541.34**	**697.38**	**295.28**	**798.97**	**553.38**	**156.5**	**105.29**	**31075.47**
Mean	**54.13**	**69.74**	**29.53**	**79.90**	**55.34**	**15.65**	**10.53**	**3107.55**

Table 8: Concentration of Residual 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	**73.19**	**80.19**	**42.37**	**100.47**	**60.3**	**18.68**	**13.62**	**5535.59**
5-10	**70.59**	**79.27**	**42.33**	**94.46**	**59.78**	**18.99**	**13.3**	**5985.66**
15-20	**70.16**	**70.02**	**41.72**	**94.19**	**58.95**	**15.2**	**12.49**	**5635.51**
20-25	**66.2**	**69.72**	**41.41**	**86.12**	**58.13**	**15.12**	**12.38**	**4253.12**
25-30	**62.37**	**69.12**	**31.38**	**80.05**	**55.95**	**15.08**	**10.92**	**4002.67**
30-35	**59.15**	**62.98**	**26.38**	**77.21**	**55.61**	**14.92**	**10.56**	**3856.21**
35-40	**51.67**	**62.53**	**26.19**	**77.12**	**53.56**	**12.6**	**10.34**	**3122.94**
40-45	**40.61**	**60.16**	**22.64**	**69.35**	**53.26**	**12.18**	**9.73**	**3522.17**
45-45	**42.57**	**59.29**	**19.01**	**60.65**	**50.88**	**12.03**	**8.27**	**3994.27**
45-50	**42.86**	**50.47**	**18.47**	**59.99**	**48.7**	**11.87**	**6.78**	**2642.61**
Total	**579.37**	**663.75**	**311.9**	**799.61**	**555.12**	**146.67**	**108.39**	**42550.75**
Mean	**57.94**	**66.36**	**31.19**	**79.96**	**55.51**	**14.67**	**10.84**	**4255.08**

Table 9: Concentration of Residual 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	69.63	81.03	45.52	98.56	65.89	17.83	11.74	20,158.26
5-10	68.77	80.9	45.15	93.56	64.83	16.07	11.26	19,854.26
15-20	65.75	75.52	44.47	87.6	63.78	15.76	10.61	17,521.23
20-25	60.54	72.59	42.12	84.1	60.7	14.99	10.75	15,672.31
25-30	58.97	71.86	41.46	81.3	59.14	14.06	10.18	12,548.10
30-35	57.65	69.23	40.03	76.07	57.07	13	9.84	10,775.16
35-40	54.77	69.17	37.22	73.89	55.49	12.63	9.19	8,759.23
40-45	46.24	68.47	32.46	71	54.8	12.05	8.58	7,819.24
45-45	43.64	66.05	28.52	69.1	45.19	11.99	8.28	7,024.18
45-50	41.11	63.32	25.19	68	53.79	11.07	7.97	6,975.64
Total	567.07	718.14	382.14	803.18	580.68	139.45	98.4	127107.6
Mean	56.71	71.81	38.21	80.32	58.07	13.95	9.84	12710.76

Table 10: Concentration of Residual 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	69.63	81.03	38.52	98.56	64.89	17.83	15.98	2295.49
5-10	68.77	76.9	35.52	93.52	63.83	17.07	15.78	2021.49
15-20	68.75	76.52	32.47	90.6	63.78	16.96	15.32	1885.52

20-25	68.54	64.59	30.56	80.44	63.7	16.49	15.25	1782.26
25-30	58.97	61.86	30.46	80.26	60.14	16.06	13.92	1525.18
30-35	57.65	58.83	30.03	80.07	50.07	14.8	13.75	1125.65
35-40	50.77	58.57	27.82	72.89	57.49	14.63	11.95	925.57
40-45	46.24	60.47	27.46	64.73	54.8	10.95	11.87	915.97
45-45	43.64	65.05	22.52	64.1	54.19	10.2	11.2	872.83
45-50	41.11	65.32	21.89	62	44.79	10.07	10.64	770.15
Total	574.07	669.14	297.25	787.17	577.68	145.06	135.66	14120.11
Mean	57.41	66.91	29.73	78.72	57.77	14.51	13.57	1412.01

Table 11: Concentration of Residual 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	68.95	82.07	34.37	102.87	63.06	16.72	11.88	4651.72
5-10	68.42	81.77	32.37	102.07	62.47	15.27	11.53	4351.72
15-20	66.14	78.77	32.01	98.83	60.51	14.48	10.74	3263.28
20-25	64.79	75.32	30.49	98.04	60.36	14.17	10.27	3152.16
25-30	57.95	75.21	30.21	80.16	58.58	13.74	10.07	3525.04
30-35	57.55	74.55	27.99	80.06	58.27	13.52	9.58	2996.61
35-40	56.93	73.15	24.95	81.27	55.89	13.04	9.27	2959.73
40-45	56.76	66.26	24.91	77.48	55.48	11.61	6.96	2982.53
45-45	46.31	62.55	24.07	75.26	55.16	11.18	6.49	2425.07
45-50	40.63	60.03	22.06	67.99	53.25	10.75	8.24	2119.47
Total	584.43	729.68	283.43	864.03	583.03	134.48	95.03	32427.33
Mean	58.44	72.97	28.34	86.40	58.30	13.45	9.50	3242.73

-Contamination Factor (CF) in Residual 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 in the residual phase was (2.23) at (0-5 cm) depth in Al-Qarma station and the lowest value was (4.93) at (45-50 cm) depth in Al-Fao station.According to Table (1), the CF value for Pb are (1≤CF≤3) to (3≤CF<6), indicating that this environment were moderate contamination to considerable contamination.

Nickel (Ni): The highest value of Contamination Factor (CF) of Nickel in the residual phase was (1.02) at (0-5 cm) depth in Al-Qurna station and the lowest value was (0.60) at (40-50 cm) depth in Al-Qarma station.According to Table (1),the CF value for Ni are (CF<1) to (1≤CF≤3), indicating that this environment were low contamination to moderate contamination.

Copper (Cu): The highest value of Contamination Factor (CF) of Copper in the residual phase was (0.76) at (0-5 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 (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 residual phase was (1.01) at (0-5 cm) depth in Al-Fao station and the lowest value was (0.54) at (45-50 cm) depth in Al-Qurna station.

According to Table (1), the CF value for Cr are (CF<1) to (1≤CF≤ 3), indicating that this environment were low contamination to moderate contamination.

Zinc (Zn): The highest value of Contamination Factor (CF) of Zinc in the residual phase was (0.94) at (0-5 cm) depth in Al-Ashar station, and the lowest value was (0.64) at (45-50 cm) depth in 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 residual phase was (0.75) at (0-5 cm) depth in Al-Deer station and Al-Qarma station, and the lowest value was (0.33) at (45-50 cm) depth in Al-

Qurna 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 residual phase was (106.53) at (0-5 cm) depth in Abu-Alkasib station and the lowest value was (43.27) at (40-45 cm) depth in Al-Fao 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 in the residual phase was (0.36) at (0-5 cm) depth in Al-Ashar station and the lowest value was (0.01) at (40-50 cm) depth in Abu-Alkasib station. According to Table (1), the CF value for Fe are (CF<1), indicating that this environment were low contamination.

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

The Pollution Load Index (PLI) of residual Heavy Metals inversely proportional with the depth for all stations, whereas the highest value of Pollution Load Index (PLI) in the exchangeable phase was (2.16) at (0-5 cm) depth in Al-Qurna station and the lowest value was (1.21) at (45-50 cm) depth in Al-Qurna 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 Residual Heavy 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 residual phase was (178.11) at (20-25 cm) depth in Al-Qurna station and the lowest value was (7.48) at (5-10 cm) depth in Al-Ashar station. According to Table (2), the EF value for Pb are (EF = 5-10) to (EF >50), indicating that this environment were moderate to severe enrichment to extremely severe enrichment.

Nickel (Ni): The highest value of Enrichment Factor (EF) of Nickel in the residualphase was (40.19) at (20-25 cm) depth in Al-Qurna station and the lowest value was (2.12) at (0-5 cm) depth in Al-Ashar station. According to Table (2), the EF value for Ni are (EF <3) to (EF= 25-50), indicating that this environment were minor enrichment to very severe enrichment.

Copper (Cu): The highest value of Enrichment Factor (EF) of Copper in the residual phase was (21.90) at (20-25 cm) depth in Al-Qurna station and the lowest value was (1.08) at (0-10 cm) depth in Al-sharA station. According to Table (2), the EF value for Cu are (EF <3) to (EF = 10-25), indicating that this environment were minor enrichment to severe enrichment.

Chrome (Cr): The highest value of Enrichment Factor (EF) of Chrome in the residual phase was (36.83) at (45-50 cm) depth in Abu-Alkasib station and the lowest value was (1.76) at (0-5cm) depth in Al-Ashar station. According to Table (2), the EF value for Cr are (EF <3) to (EF= 25-50), indicating that this environment were minor enrichment to very severe enrichment.

Zinc (Zn): The highest value of Enrichment Factor (EF) of Zinc in the residual phase was (37.10) at (20-25cm) depth in Al-Qurna station, and the lowest value was (1.72) at (0-5 cm) depth in Al-Ashar station. According to Table (2), the EF value for Zn are (EF <3) to (EF= 25-50), indicating that this environment were minor enrichment to very severe enrichment.

Cobalt (Co): The highest value of Enrichment Factor (EF) of Cobalt in the residual phase was (24.12) at (45-50 cm) depth in Abu-Alkasib station, and the lowest value was (1.69) at (5-10 cm) depth in Al-Ashar station. According to Table (2), the EF value for Co are (EF <3) to (EF = 10-25), indicating that this environment were minor enrichment to severe enrichment.

Cadmium (Cd): The highest value of Enrichment Factor (EF) of Cadmium in the residual phase was (4,074.28) at (20-25 cm) depth in Al-Qurna station and the lowest value was (216.27) at (5-10 cm) depth in Al-Ashar station. According to Table (2), the EF value for Cd are (EF >50), indicating that this environment were extremely severe enrichment.

-Geoaccumulation Index (I-geo) in Residual Heavy Metals in Sediment Core of Study stations

From the results we found:

Lead (Pb): The highest value of Geoaccumulation Index (I-geo) of lead in the residual phase was (1.80) at (0-5 cm) depth in Al-Qarma station and the lowest value was (0.29) at (45-50 cm) depth in Al-Qurna station. According to Table (3), the I-geo value for Pb are (I-geo=1-2), indicating that this environment were unpolluted to moderately polluted.

Nickel (Ni): The highest value of Geoaccumulation Index (I-geo) of Nickel in the residual phase was (-0.56) at (0-5 cm) depth in Al-Qurna station and the lowest value was (-1.32) at (45-50 cm) depth in Al-Qarma station. According to Table (3), the I-geo value for Ni are (I-geo<0), indicating that this environment were practically unpolluted.

Copper (Cu): The highest value of Geoaccumulation Index (I-geo) of Copper in the residual phase was (-0.98) at (0-5 cm) depth in Al-shar station and the lowest value was (-2.28) at (45-50 cm) depth in Al-Qarma 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 residual phase was (-0.57) at (0-5 cm) depth in Al-Fao station and the lowest value was (-1.47) at (45-50 cm) depth in Al-Qurna 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 residual phase was (-0.67) at (0-5 cm) depth in Al-Ashar station and the lowest value was (-1.23) at (45-50 cm) depth in 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 residual phase was (-0.98) at (5-10 cm) depth in Al-Qarmastation and the lowest value was (-2.18) at (45-50 cm) depth in Al-Qurna 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 the residual phase was (6.15) at (0-5 cm) depth in Al-Qurna station and Abu-Alkasib station and the lowest value was (4.85) at (45-50 cm) depth in Al-Fao station. According to Table (3), the I-geo value for Cd are (I-geo=4-5) to (I-geo >5), indicating that this environment were strongly to extremely polluted to extremely polluted.

Iron (Fe): The highest value of Geoaccumulation Index (I-geo) of Iron in the residual phase was (-2.07) at (0-5cm) depth in Al-Ashar station and the lowest value was (-6.78) at (45-50 cm) depth in Abu-Alkasibstation. 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 Residual 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 residual phase was (2.79) at (45-50 cm) depth in Al-Qurna station and the lowest value was (1.01) at (5-10cm) depth in Al-Qurna station, Al-Ashar 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 residual phase was (1.59) at (45-50 cm) depth in Al-Qarma station and the lowest value was (1.00) at (5-10cm) depth in Al-Ashar station and Al-Fao 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 in all station accept in Al-Ashar station and Al-Fao station at (5-10cm) depth (AF=1.00), indicating that this environment have no metal enrichment of anthropogenic origin.

Copper (Cu): The highest value of Anthropogenic Factor (AF) of Copper in the residual phase was (2.29) at (45-50 cm) depth in Al-Qarma station and the lowest value was (1.00) at (5-10cm) depth in Al-Qarma 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 in all stations accept in Al-Qarma station at (5-10cm) depth (AF=1.00), indicating that this environment have no metal enrichment of anthropogenic origin.

Chrome (Cr): The highest value of Anthropogenic Factor (AF) of Chrome in the residual phase was (1.81) at (45-50 cm) depth in Al-Qurna station and the lowest value was (1.01) at (5-10cm) depth in Fao station. According to Table (5), the AF value for Cr are(AF>1 fora particular metal), indicating that this environment have anthropogenic input and the contamination exists.

Zinc (Zn): The highest value of Anthropogenic Factor(AF) of Zinc in the residual phase was (1.46) at (45-50 cm) depth in Al-Ashar station, and the lowest value was(1.00) at (5-10cm) depth in Al-Qurna station. According to Table (5), the AF value for Zn are (AF>1 for a particular metal), indicating that this environment have anthropogenic input andthe contamination exists in all stations accept in Al-Qurna station at (5-10cm) depth (AF=1.00), indicating that this environment have no metal enrichment of anthropogenic origin.

Cobalt (Co): The highest value of Anthropogenic Factor (AF) of Cobalt in the residual phase was (1.82) at (45-50cm) depth in Al-Qurna station and the lowest value was(0.98) at (5-10cm) depth in Al-Qarma station. According to Table (5), the AF value for Co are (AF>1 for a particular metal), indicating that this environment have anthropogenic input andthe contamination exists in all stations accept in Al-Qarma station at (5-10cm) depth (AF<1), indicating that this environment have no metal enrichment of anthropogenic origin.

Cadmium (Cd): The highest value of Anthropogenic Factor (AF) of Cadmium in the residual phase was (2.01) at (45-50 cm) depth in Al-Qarma station and the lowest value was(1.01) at (0-5cm) depth in Al-Deer station and Abu-Alkasib station .According to Table (5), the AF value for Cd are (AF>1 for a particular metal), indicating that this environment have anthropogenic input andthe contamination exists.

Iron (Fe): The highest value of Anthropogenic Factor(AF) of Iron in the residual phase was (3.07) at (45-50cm) depth in Al-Deer station and the lowest value was(0.92) at (5-10cm) depth in Al-Qarma station. According to Table (5), the AF value for Fe are (AF>1 for a particular metal), indicating that this environment' have anthropogenic input andthe contamination exists in all stations accept in Al-Qarma station at (5-10cm) depth(AF<1) indicating that this environment have no metal enrichment of anthropogenic origin.

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 iron metal in Al-Qurna, Al-Deer, Al-Qarma and Al-Fao stations in the residual phase.

References

[1]. Santos, I.R., Silva-Filho, C.E., Schaefer, C.E., Albuquerque - Filho, M.R. and Campos, L.S. (2005). Heavy metals contamination in coastal sediments and soil near the Brazilian Antarctic Station, King George Island. Marine Pollution Bulletin, 50, 185-194.

[2]. Muthu, R.S. and Jayaprakash, M. (2008). Distribution and enrichment of trace metals in marine sediments of Bay of Bengal, off Ennore, South-east coast of India. Environmental Geology, 56, 207-217.

[3]. Winkels, H.J., Vink, J.P.M. and Beurskens, J.E.M. (1993). Distribution and geochronology of priority pollutants in a large sedimentation area, River Rhine, Netherland. Applied Geochemistry, S2, 95-101

[4]. Buckley, D.E., Smith, J.N. and Winters, G.V. (1995) .Accumulation of contaminants metals in marine sediments of Halifax Harbour, Nova Scotia: Environmental factors and historical trends. Applied Geochemistry, 10, 175-195.

[5]. Uzairu, A., Harrison, G.F.S., Balarabeand, M. L., Nnaji, J.C. (2009). Concentration Levels of Trace Metals In Fish And Sediment From Kubanni River, Northern Nigeria. Bull. Chem. Soc. Ethiop, 23(1), 9pp.

[6]. Sturgeon, R.E., Desaulincrs, J.A., Berman, S.S. and Russell, D.S. (1982). Determination of trace metals in estuarine sediment by graphite furnace atomic absorption spectrophotometry Anal. Chem. Acta., 134: 288-291.

[7]. Hakanson, L. (1980). An Ecological Risk Index for Aquatic Pollution Control a Sedimentological Approaches, *Water Research*, 14(8), 975-1001.

[8]. Huheey, J. E. (1983). Inorganic chemistry: Principles of structure and reactivity. Harper and Row Publishers, New York, 912.

[9]. Atgin, R. S.; O. El-Agha; A. Zararsiz; A. Kocatas; H. Parlak and G. Tuncel. (2000). Investigation of the sediment pollution in Izmir Bay: trace elements. Spectrochim. Acta B., 55 (7), 1151-1164.

[10]. Muller, G. 1969. Index of Geoaccumulation in sediments of the Rhine River. Geol. J. 2, 109-118.

[11]. Kabata-Pendias, A. (2011)**.** Trace elements in soils and plants. 4th Edition, CRC Press

[12]. Tomlinson, D.L.; J.G. Wilson; C.R. Harris and D.W. Jeffery. (1980). Problems in the assessment of heavy metals levels in estuaries and the formation of a pollution index. HelgolWiss. Meeresunters, 33 (1-4), 566-575.

[13]. Szefer, P.; Geldon, J.; Ahmed Ali, A.; Paez Osuna, F.; Ruiz Fernandes, A. C.; Guerro Gaivan, S. R., (1998). Distribution and association of trace metals in soft tissue and byssus of *Mytella strigata* and other benthal organisms from Mazatlan Harbour, Mangrove Lagoon of the northwest coast of Mexico. Environ. Int., 24 (3), 359-374: 16 pp.

[14]. Ruiz-Fernandez, A. C.; Paez-Osuna, F.; Hillaire-Marcel, C.; Soto-Jimenez, M.; Ghaleb, B., (2001). Principal component analysis applied to assessment of metal pollution from urban wastes in the Culiacan river estuary. Bull. Environ. Contam. Toxicol., 67 (5), 741-748 (9 pages)