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Heavy metal distribution in grain size fraction in surface sediments: pollution assessment of Iraqi Coasts

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ABSTRACT

The distribution of grain size in coastal sediments may provide information on the existence and environment of the sedimentation processes and their transport. Ten samples were tested for sieve analysis. the samples was sieved in sieves arranged from coarse to fine as follow (4, 2, 1, 0.5, 0.25, 0.355, 0.12, 0.075, 0.038 mm and pan). Samples were analyzed with AAS for Cd, Ni, Cu, Mn and Fewhile V and Aswere measured by using the ICP technique. The overall result was as shown: Al>Fe>Mn>V>Cu>As>Pb>Ni>Cd. The Arsenic concentration exceeded the detection limits, for most metals, the presence of heavy metals in multiple classes of particle sizes showed greater accumulations in fractions of fine-scale. That the level of metals increases as the size of the particle decreases excluding for Fe, Ni, and Pb The low E.F. in both bulk and fractionated samples. The high E.F. values in ST.5 for Pb in 0.15 mm and ST.8 for Ni in 0.355mm fractions exceeded 2.0. According to The results of I-geo, the sediments were contaminated with Al, As, Fe, and Pb, while they were uncontaminated with the elements Cd, Cu, Mn, Ni, V and the degrees of contamination differed according to this criterion.

***Key words** : Iraqi cost line, Heavy metals, Grain size, Pollution*

Introduction

Khor Al-Zubair and Shatt Al-Arab coasts of Iraq are expanding regions. Major sources of pollution in this section of the Arabian Gulf are water discharges from ships, ballast water discharges, and marine transport operations. Additional pollutant sources in this coastal area are, however, industrial and agricultural dredging. Activities such as this can cause all kinds of toxins along the Iraqi coasts (Al-Khuzaie, 2020; Awadh and Ahmed, 2013). According to Hassan, (2018) and Al- Jaberi *et al.*, (2018) the relatively high levels some pollution in Kour Al-Zuber tidal flat sediments according to anthropogenic sources such as untreated wastewater and oil spills. The coastal and estuarine sediments typically like a sponge receiving the metals by sorption on the suspended matter and subsequent sedimentation (Abdulnabi *et al.*, 2019; Al-Dabbas and Al-Jaberi, 2015; Al-Jaberi *et al.*, 2016; Hassan *et al.*, 2008) Sediment pollution by heavy metals is a far-reaching issue. Metal pollution sources can be from agriculture, industry, mining, and metropolitan life or from natural activity, like an automatic result of human and normal activities, for example, the settling of wind-borne particles (Al-Jaberi *et al.*, 2016; Awadh

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and Ahmed, 2013; Hassan, 2018; Orroño and Lavado, 2009).

In aquatic systems, heavy metals are rapidly increasing and are often used as an intermediate measurement for contaminants in aquatic systems due to rapid urbanization (Al-Saady *et al.,* 2021; Castillo *et al.,* 2013). Sediment properties are still not understood and even the bioavailability factors of heavy metals in sediments have never been fully considered. The distribution of trace metals in sediments adjacent to residential areas may provide evidence of an anthropogenic effect on the aquatic environment and the ease of evaluating the possible consequences of human waste discharge (Al-Jumaily and Al-Berzanje, 2020; Al-Kaaby and Albadran, 2020; Khaleefah *et al.,* 2019; Zhang *et al.,* 2014). Large amounts of native sediments and their related contaminants would have a significant impact on the marine and coastal environment (Abas *et al.,* 2019; Feng *et al.,* 2004; Hsu and Lin, 2010; Rocha *et al.,* 2011; Song *et al.,* 2010; Weber *et al.,* 2009; Zhang, 1999).

The associated clay minerals, organic matter, Fe-oxide, Al-oxides, and Mn-oxide form fine-sized aggregates that have a large specific surface area to control heavy metal contamination in the particulate fraction of the grain size (Cai *et al.,* 2002; Hassan *et al.,* 2008; Hassan, 2018; Ljung *et al.,* 2006; Semlali *et al.,* 2001). It is also important to analyze the particle Physical chemical properties concentration of heavy metal affecting in the grain size. The environmental activity of heavy metals in sediments influenced by particle size sediments, which play aimportant role in the adsorption, distribution, and migration of heavy elements in sediment particles, has shown the greater ability of fine sediment particles to associate heavy metals (Castillo *et al.,* 2013; Huang *et al.,* 2020).

It is important to understand the effects of heavy metals on human health to recognize such an adjustment (Karande *et al.,* 2020). Arsenic in natural waters and sediments is closely related to the presence of arsenate and arsenate iron oxides, which are highly sorbed on the surfaces of iron oxides, creating complexes of the inner sphere. Simultaneous occurrence of high concentrations of soluble As and Fe(II) in anoxic groundwater has led to the deduction that the reductive breakdown of As rich Fe(III) (hydro-oxides) mobilizes (Hassan *et al.,* 2008; McDevitt *et al.,* 2019). More recently, it has been determined that in As-ferri hydrate environments, As-bearing ferrihydrite is converted and dissolved by microbial sulfide creation. Iron may be reduced by microorganisms, resulting in As being sequestered to secondary ferrous minerals (McDevitt *et al.,* 2019; Violante *et al.,* 2010). Heavy metals pollution in Iraq's marine environment has been studying by many previous,which mostly focused on the conce., distribution, source, enrichment, and environmental risks of heavy metal pollution (Abas *et al.,* 2019; Abdulnabi *et al.,* 2019; Al-Jaberi *et al.,* 2016; Al-Khuzaie, 2015; Al-Khuzie *et al.,* 2017; Hassan *et al.,* 2008; Hassan, 2018).

Heavy metals are adsorbed to sediment surface particles and controlled by sediment and water movements (Violante *et al.,* 2010). Thus, understanding the characteristics of the surface sediment and the concentration of heavy metals has a very important meaning to make known the trend of accumulation of heavy metals in the Iraqi tidal flat system. The specific objectives of this study are: (1) to clarify the spatial distribution of the concentrations of heavy metals (Zn, Cr, Pb, Ni, Cu, and Co) in surface sediments from the Iraqi flat surface; (2) to analyze the interrelationship between the distribution of heavy metals and the grain size characteristics of the surface sediment from the point of view of dynamic sedimentology.

Materials and Methods

Sample Collection

Samples of surface sediments were collected in summer 2017 from 10 representative points for each site, throughout the Iraqi tidal flats on the North West Arabian Gulf (Fig. 1). GPS and other devices have been used for sampling. The sediments are put in bags of polyethylene. In the laboratory, some of the sediments air-dried than sieved through 200 mm of stainless steel these samples were ready for analysis.

Analytical methods

The sediment samples were analyzed for grain size analysis (Sand Silt and clay) using the pipette method as described in (Black *et al.,* 1965). Sediments texture calculatoruse this tool to calculate a single point texture class established on percent sand, silt, and clay (USDA). The sieve analysis is used for sands.

Ten samples were analyzed in a series of sieve

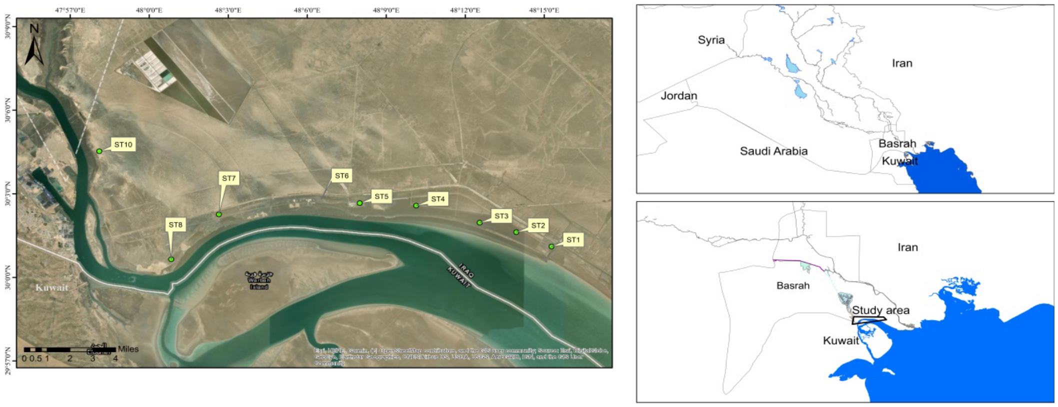

Fig. 1. The sampling station in the study area

analyses, part of the samples was dried in the oven, while others were used as context samples, the dry sample was collected and emptied in a set of sieves organized from rough to fine as follows (4, 2, 1, 0.5, 0.25, 0.355, 0.12, 0.075, 0.038 mm and pan). The set of sieves was fixed to a mechanical shaker. The sample had been shook for about 15 minutes. The retained weights have been registered using the responsive balance. For both samples, the weight percentages and the total weight percentages were determined.

The sieved sediments were digested in each sieve by a mixture of $HClO_4$,HF , and HNO3 after which 0.5M $HClO_3$ was applied to the solution (50 ml) (Sparks *et al.*, 1996). after that brought into solution in 0.5M HCl (50 ml). The total concentration of sixheavy metals (Cd, Ni, Cu, Mn, Fe, Pb) in samples were analyzed by A.A.S.(Atomic Absorption Spectroscopy type Phoenix 986AA) while Vanadiumand Arsenic were measured by using ICP techniquetype ICP-OES HORIBA JY 2000-2.

For the bulk sediment sample, the fractional accumulation of metal (MAF) at each fraction of the diameter was determined using Eq. (1).

$$MAF = \frac{\text{M fraction}}{\text{bulk}} \quad .. (1)$$

Where the amounts of metal (mg/kg) are M fraction and M bulk in a specified fraction of the particle size and a bulk sample.

Determination of Contamination Factor (C.F)

In the current analysis, the C.F factor was used to assess the pollution status of sediments. C.F was calculated according to Eq.(2)

$$C.F = \frac{Mc}{Bc} \quad .. (2)$$

Where: Mcmeasured the concentration of the metallic and Bc is the background conc. ofthe same metallic. Four pollution groups are depending on the contamination factor (Hakanson, 1980). CF<1 low; 1≤CF≤ 3 moderate; 3 ≤ CF<6 considerable; CF>6 very high.

Enrichment factor (E.F).

The metal EF is defined as follows:

$$E.F = \left(\frac{Xi}{Fe}\right) \text{sediment} \,/ (Xi/Fe) \text{crust} \quad .. (3)$$

Where Xi/Fe is the ratio of the concentration heavy metal (Xi) to the Fe concentration in the sample.

E.F values were taken as submitted by (Sutherland, 2000) for the metals studied concerning crust average 5% (Kabata-Pendias, 2010).There are 6 types as following:< 1 no enrichment; < 3 minor enrichment; 3–5 moderate enrichment;5–10 moderate to severe enrichment; 10–25 severe enrichment; 25–50; very severe enrichment and> 50 extremely severe enrichment.

Determination of geoaccumulation index(I-geo)

The I –geo index values were calculated for different metals as presented by(Muller, 1969) is as follows :

$$I - geo = \log 2 \left(\frac{Cn}{1.5Bn}\right) \quad .. (4)$$

Where Cn is the approximate concentration of metal n in the sediment and Bn is the history geo accumulation for metal n which is the average shale value (Kabata-Pendias, 2010). when I-geo <0 practically unpolluted- Background sample; 1-2 unpolluted to moderately polluted;2-3 moderately polluted to polluted; 4-5 strongly to extremely polluted and>5 extremely polluted.

Results

Grain Size Distribution in Sediments

Table 1 reveals that much of the tidal flat sediments are muddy sand and sand. The grain size of the coast sediments influences the mode and the distance of transport: the finer size, the greater the distance (Rashedi and Siad, 2016).

Table 1. Distribution of grain size and texture in sediment samples

Sample	%graval	%sand	%Mud	Type
ST1	0.00	83.67	16.33	Muddy Sand
ST2	0.00	53.72	46.28	Muddy Sand
ST3	0.00	62.29	37.71	Muddy Sand
ST4	1.75	78.37	19.88	Muddy Sand
ST5	0.00	99.92	0.08	Sand
ST6	1.02	82.61	16.37	Muddy Sand
ST7	0.59	64.76	34.65	Muddy Sand
ST8	0.95	80.35	18.70	Muddy Sand
ST9	0.45	71.51	28.05	Muddy Sand
ST10	0.96	57.44	41.60	Muddy Sand

Some of the sediments on the beach are muddy sand and sand. Sand concentration was highest in station 5 (99.92%) and lowest in station 2 (53.72%). Gravel percentage is almost non-existent at all stations.

Metals in bulk and fractions of grin size

Compared to local tradition, the samples were marginally smaller, Table 2 show Conce. of selected heavy metals in bulk sedimentsfor all samples were as follows : Al(2.40-4.75)% with an average of 3.13%, As (12.40-24.60) mg/kg with an average of 19.28 mg/kg, Cd (0.06-0.11) mg/kg with an average of 0.08 mg/kg, Cu (109.16-738.15) mg/kg with an average of 453.43 mg/kg, Fe (11005.95-13355.63) mg/kg with an average of 12404.01 mg/kg, Mn (304.37-1085.67) mg/kg with an average of 740.56 mg/kg, Ni (45.81-206.51) mg/kg with an average of 147.38 mg/kg, Pb (327.01-1093.97) mg/kg with an average of 697.16 mg/kg, V(201-362) mg/kg with an average of 257.25 mg/kg.

The results in Fig. 2 have shown that, most of the elements concentrate in 0.075 mm size fraction, except Fe and As have 35% and 42%. Whereas just around 20% was present in the 0.15-0.355 mm fraction. The fraction <0.355 mm contained roughly 5-20% of the total metal and its contents. Except for Fe more than 30%. Table 3 indicates that the content of most elements in ST1 has the highest value, in all fractions, except Al and Pb in ST7. However, retain the same structure for the gradient fraction. In all samples, Al, Fe, Mn, and V were the dominant elements. Other detectable elements were Cu and As. However, Ni and Cd in some samples (Tables 2 and 3). The dominance of the elements in the samples was the following arrangement: Al>Fe> Mn> V> Cu> As> Pb>Ni>Cd.

The metal accumulation factors (MAF) showed

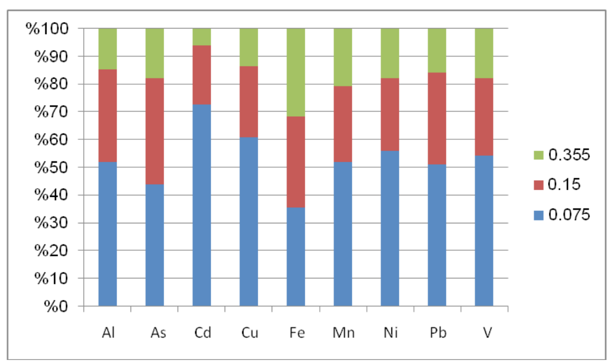

Fig. 2. Indicates the average percentage of each element analyzed found in the sediments under review.

Table 2. Means, Min and Max of heavy metal sampled in chosen bulk sediments

Stations	Al%	As mg/kg	Cd mg/kg	Cu mg/kg	Fe mg/kg	Mn mg/kg	Ni mg/kg	Pb mg/kg	V mg/kg
ST1	2.56	24.60	0.11	738.15	12959.38	909.33	206.51	327.01	362.00
ST5	2.80	20.00	0.06	494.39	13355.63	1085.67	205.37	1093.97	230.00
ST7	4.75	12.40	0.06	472.01	12299.06	662.86	131.81	859.60	236.00
ST10	2.40	20.10	0.10	109.16	11005.95	304.37	45.81	508.07	201.00
Average	3.13	19.28	0.08	453.43	12405.01	740.56	147.38	697.16	257.25
Min	2.40	12.40	0.06	109.16	11005.95	304.37	45.81	327.01	201.00
Max	4.75	24.60	0.11	738.15	13355.63	1085.67	206.51	1093.97	362.00

that finest fractions 0.075 mm had the highest values in all the elements and for the four stations studied.

The results of the MAF calculation indicated that more than half of the total concentration of the elements was adsorbed on these particles and for all the studied elements except Al, Fe, and Pb. For stations 1, 7, and 10 The following determination coefficients Ni>Cu>Fe>Pb>Mn>V>As>Al>Cd> were used to show the declining concentrations of chosen heavy metals with increasing particle size (Table 4).

The results of calculation C.F showed that all stations were polluted according to this criterion with all the studied elements except for the Mn and V, as the values of C.F ranged for Al (30-59.38) with a rate of 39.13 depending on the total concentration in the sample before separation as shown in the Table 5.

ST10 scored the lowest, while ST7 was the highest. The other elements exhibited the same behavior as their C.F values ranged as follows: As (6.89-13.67) with a rate of 10.71; Cu (4.2-28.39), a rate of 17.44; Fe (22.01-26.71), a rate of 24.81; Ni(2.29-10.33), a rate of 7.37; and Pb (22.55-75.45) a rate of 48.08.

The results showed that (when evaluating with C.F and depending on the total concentration in bulk samples) all stations were highly contaminated with As, Cu, Fe, Pb and less pollution with Ni. While when adopting the concentration of the element in the particles, the results showed that the contamination was less than that in the bulk sample Table (6), as the C.F values of Al ranged from (2.88-13.03), while the rates of C.F. for As (0.94-6.84) decreased for Cu (0.57-17.43); Fe (6.78 -9.18); Ni (0.37-6.73) and Pb (6.68-41.37), indicating that the adoption of the decision in the evaluation gives a lower picture than in the bulk samples. while the rates of C.F. for As (0.94-6.84) decreased for Cu (0.57-17.43); Fe (6.78 -9.18); Ni (0.37-6.73) and Pb (6.68-41.37), indicating that the adoption of the definitive in the

Table 3. Mean of heavy metal in selected fraction gran size sediments sample

Stations	Sieve size Mm	Al %	As mg/kg	Cd mg/kg	Cu mg/kg	Fe mg/kg	Mn mg/kg	Ni mg/kg	Pb mg/kg	V mg/kg
ST1 0.075	0.89	12.4	0.07	453.15	4590	518.35	134.52	119.91	260	
	0.150	0.84	8.5	0.04	213.62	4340.63	232.05	42.48	110.25	71
	0.355	0.83	3.7	0	71.38	4028.75	158.93	29.51	96.85	31
ST5	0.075	1.42	7	0.06	213	4500.31	435	80.57	522.7	97
	0.150	0.93	6.7	0	171.08	4488.13	373.17	76.81	447.07	85
	0.355	0.45	6.3	0	110.31	4367.19	277.5	47.99	124.2	48
ST7	0.075	2.3	5.6	0.06	374.08	4552.81	414.51	88.72	599.93	101
	0.150	2.12	5.1	0	51.31	3879.06	131.03	22.33	152.63	82
	0.355	0.33	1.7	0	46.62	3867.19	117.32	20.76	107.04	53
ST10	0.075	1.9	9	0.05	66.08	3992.19	171.56	26.54	187.80	100
	0.150	0.27	9	0.03	28.31	3621.88	77.41	11.91	206.8	51
	0.355	0.23	2.1	0.02	14.77	3391.88	55.4	7.36	113.47	50

Table 4. The metal accumulation infraction (MAF)

Stations	Sieves (mm)	Al	As	Cd	Cu	Fe	Mn	Ni	Pb	V
ST1	0.075	0.35	0.50	0.64	0.61	0.35	0.57	0.65	0.37	0.72
	0.15	0.33	0.35	0.36	0.29	0.33	0.26	0.21	0.34	0.20
	0.355	0.32	0.15	0.00	0.10	0.31	0.17	0.14	0.30	0.09
ST5	0.075	0.51	0.35	1.00	0.43	0.34	0.40	0.39	0.48	0.42
	0.15	0.33	0.34	0.00	0.35	0.34	0.34	0.37	0.41	0.37
	0.355	0.16	0.32	0.00	0.22	0.33	0.26	0.23	0.11	0.21
ST7	0.075	0.48	0.45	1.00	0.79	0.37	0.63	0.67	0.70	0.43
	0.15	0.45	0.41	0.00	0.11	0.32	0.20	0.17	0.18	0.35
	0.355	0.07	0.14	0.00	0.10	0.31	0.18	0.16	0.12	0.22
ST10	0.075	0.79	0.45	0.50	0.61	0.36	0.56	0.58	0.37	0.50
	0.15	0.11	0.45	0.30	0.26	0.33	0.25	0.26	0.41	0.25
	0.355	0.10	0.10	0.20	0.14	0.31	0.18	0.16	0.22	0.25

Contaminant Factor of heavy metal (C.F)

evaluation gives a lower description than in the bulk samples

Metal enrichment factors (E.F)

Table 7 shows the EF of the Al, As, Cd, Cu, Mn, Ni, Pb, and V in each sample. In bulk sediment, E.F below 1 was found for all elements except Al and Pbin all samples. E.FAl and E.FPb varied from 1.36 to 2.22 and from 0.84 to 2.73 respectively, while the values of E. FCu ranged from 0.19 to 1.06 for ST 10 and ST1 respectively.

The calculated E.F values for the fine particles are shown in Table 8. The E.F in the 0.075 mm fraction of the following metals in all sediment in the study area were less than 1 except Al, Cu, and Pb in some stations and more than 1 in most stations. The highest values were found in fine grains 0.075 mm and the smallest values were recorded in coarse grains 0.355 mm. Station 7 recorded the highest values for fine particles, while station 10 recorded the lowest values for coarse particles. Copper E.F values of the stations analyzed and the granular sizes are chosen ranged from 0.08-1.99. The results indicated that the sediments were not contaminated according to this parameter except for stations 1 and 8 in grains with diameters of 0.075, which recorded 1.99 and 1.58 for

Table 5. Mean of Contaminant Factor of heavy metal (C.F) in selected bulk sediments sample

Stations	Al	As	Cd	Cu	Fe	Mn	Ni	Pb	V
ST1	32.00	13.67	0.73	28.39	25.92	0.86	10.33	22.55	1.45
ST5	35.00	11.11	0.40	19.02	26.71	1.03	10.27	75.45	0.92
ST7	59.38	6.89	0.40	18.15	24.60	0.63	6.59	59.28	0.94
ST10	30.00	11.17	0.67	4.20	22.01	0.29	2.29	35.04	0.80
Average	39.13	10.71	0.53	17.44	24.81	0.70	7.37	48.08	1.03
Min	30.00	6.89	0.40	4.20	22.01	0.29	2.29	22.55	0.80
Max	59.38	13.67	0.73	28.39	26.71	1.03	10.33	75.45	1.45

Table 6. Mean of Contaminant Factor of heavy metal (C.F) infraction selected sediments sample

Station	Sieve (Mm)	Al	As	Cd	Cu	Fe	Mn	Ni	Pb	V
ST1	0.075	11.13	6.89	0.47	17.43	9.18	0.49	6.73	8.27	1.04
	0.15	10.50	4.72	0.27	8.22	8.68	0.22	2.12	7.60	0.28
	0.355	10.38	2.06	0.00	2.75	8.06	0.15	1.48	6.68	0.12
ST5	0.075	17.75	3.89	0.40	8.19	9.00	0.41	4.03	36.05	0.39
	0.15	11.63	3.72	0.00	6.58	8.98	0.35	3.84	30.83	0.34
	0.355	5.63	3.50	0.00	4.24	8.73	0.26	2.40	8.57	0.19
ST7	0.075	28.75	3.11	0.40	14.39	9.11	0.39	4.44	41.37	0.40
	0.15	26.50	2.83	0.00	1.97	7.76	0.12	1.12	10.53	0.33
	0.355	4.13	0.94	0.00	1.79	7.73	0.11	1.04	7.38	0.21
ST10	0.075	23.75	5.00	0.33	2.54	7.98	0.16	1.33	12.95	0.40
	0.15	3.38	5.00	0.20	1.09	7.24	0.07	0.60	14.26	0.20
	0.355	2.88	1.17	0.13	0.57	6.78	0.05	0.37	7.83	0.20
	Average	13.03	3.57	0.18	5.81	8.27	0.23	2.46	16.03	0.34
	Min	2.88	0.94	0.00	0.57	6.78	0.05	0.37	6.68	0.12
	Max	28.75	6.89	0.47	17.43	9.18	0.49	6.73	41.37	1.04

Table 7. Mean of E.F of heavy metal in selected bulk sediments sample

Stations	Al	As	Cd	Cu	Mn	Ni	Pb	V
ST1	1.23	0.53	0.03	1.10	0.03	0.40	0.88	0.06
ST5	1.31	0.42	0.01	0.71	0.04	0.38	2.84	0.03
ST7	2.41	0.28	0.02	0.74	0.03	0.27	2.43	0.04
ST10	1.36	0.51	0.03	0.19	0.01	0.10	1.60	0.04
Average	1.58	0.43	0.02	0.70	0.03	0.30	1.95	0.04
Min	1.36	0.31	0.02	0.19	0.01	0.10	1.03	0.04
Max	2.22	0.51	0.03	1.06	0.04	0.39	2.84	0.05

ST1 and ST8, respectively. This indicates that the two stations above are minor enrichment in fine particles.

Lead E.F values ranged from 0.80 to 4.39 for the granules and the selected stations, and the amount of contamination increased as the particle size reduced. The highest values were recorded by the station at the smallest size and moderately enrichment, while the rest of the stations were minor enrichment of the same separation.

Metal Geo accumulation Index (I-geo)

The I-geo values of the total sedimentshowed that the sediments were contaminated with Al, As and not contaminated with other elements. I-geo values ranged from 4.32-5.31 for Al and 2.2-3.19 As (Table 9). The results of the study were shown when assessing pollution with I-geo as the following I-geo $_{Al}$ values ranged from 4.32-5.31 with a rate of 4.71. The lowest values were recorded in ST10 while the highest values were recorded in ST7. As I-geo ranged from 2.2-3.19 with a rate of 2.84. ST1 recorded the highest values while ST10 recorded the lowest values. I-geo $_{Cu}$ values ranged from 1.48-4.24 with an average of 3.54. The highest values were recorded in ST1 and the lowest in ST10, like all the stations under study were highly polluted with Cu, except ST10 according to this parameter.

The values of I-geo $_{Ni}$ varied from moderate pollution to pollution according to this parameter, except for ST10, which is not contaminated. The results of Pb showed that the studied stations varied in the degree of pollution from a strongly polluted to an extremely polluted according to this parameter, as their values ranged between 3.91-5.65. The studied stations are considered not contaminated with Mn, Cd, V, and Ni according to I-geo for granules and according to the sizes shown in the study (Table 10).

For Al, the values of I-geo ranged from 0.94-4.26 and with a rate of 3.12. The smaller the granules are the more polluted Al I-geo values ranged from 4.32-5.31. ST10 recorded the lowest values while ST7 recorded the highest values. As for As, the small granules ranged from non-contaminated to moderately contaminated according to this criterion. The first

Table 8. Mean of E.F of heavy metal in selected fraction sediments sample

Stations	Sieve (Mm)	Al	As	Cd	Cu	Mn	Ni	Pb	V
ST1	0.075	1.21	0.75	0.05	1.90	0.05	0.73	0.87	0.11
	0.15	1.21	0.54	0.03	0.95	0.03	0.24	0.85	0.03
	0.355	1.29	0.26	0.00	0.34	0.02	0.18	0.80	0.02
ST5	0.075	1.97	0.43	0.04	0.91	0.05	0.45	3.87	0.04
	0.15	1.30	0.41	0.00	0.73	0.04	0.43	3.32	0.04
	0.355	0.64	0.40	0.00	0.49	0.03	0.27	0.95	0.02
ST8	0.075	3.16	0.34	0.04	1.58	0.04	0.49	4.39	0.04
	0.15	3.42	0.37	0.00	0.25	0.02	0.14	1.31	0.04
	0.355	0.53	0.12	0.00	0.23	0.01	0.13	0.92	0.03
ST10	0.075	2.97	0.63	0.04	0.32	0.02	0.17	1.56	0.05
	0.15	0.47	0.69	0.03	0.15	0.01	0.08	1.90	0.03
	0.355	0.42	0.17	0.02	0.08	0.01	0.05	1.12	0.03
Average		1.55	0.43	0.02	0.66	0.03	0.28	1.90	0.04
Min		0.42	0.12	0.00	0.08	0.01	0.05	0.80	0.02
Max		3.42	0.75	0.05	1.90	0.05	0.73	4.39	0.11

Table 9. Mean of I-geo of heavy metal in selected bulk sediments sample

Stations	Al	As	Cd	Cu	Fe	Mn	Ni	Pb	V
ST1	4.42	3.19	-1.03	4.24	4.11	-0.80	2.78	3.91	-0.05
ST5	4.54	2.89	-1.91	3.66	4.15	-0.55	2.78	5.65	-0.71
ST7	5.31	2.20	-1.91	3.60	4.04	-1.26	2.14	5.30	-0.67
ST10	4.32	2.90	-1.17	1.48	3.88	-2.38	0.61	4.55	-0.90
Average	4.71	2.84	-1.49	3.54	4.05	-1.10	2.30	5.00	-0.54
Min	4.32	2.20	-1.91	1.48	3.88	-2.38	0.61	3.91	-0.90
Max	5.31	3.19	-1.03	4.24	4.15	-0.55	2.78	5.65	-0.05

and seventh stations were recorded according to this criterion from moderately polluted to polluted with respect to Cu, Fe exhibited the same behavior as Cu. The stations studied according to I-geo for granules are the most polluted with Pb compared to the other studied elements, as their values ranged from 2.15-4.79 as the smaller separations occurred from moderately polluted to strongly polluted (Table 10).

Discussion

Grain Size Distribution in Sediments

Some of the sediments on the beach are muddy sand and sand. This suggests that sediments have been deposited in a low-energy state since sediments typically get coarser with additional energy of the conveying medium (Folk, 1974). This is consistent with the findings ofIssa *et al.*, (2009); Al-Jaberi *et al.,* (2016); Al-khuzaie, (2020), and Al-Kaaby and Albadran, (2020) who separately indicated that the sediments of the tidal flats northwest of the Arabian Gulf have a sandy to muddy sand.

Metals in bulk and fractions of grin size

This result was in agreement with Hassan, (2018) and Abdulnabi *et al.*, (2019) of all sediments, Al, Fe, and Mn are the most prevalent metals since these metals are natural elements in the crust of the Earth. In ST10, the lowest concentration of Al, Mn, and Fe is detected, while in ST 5, the highest concentration is found.Furthermore, the mean quality of the critical elements referred to above was typically lower than in some tidal flat areas. The Arsenic concentration exceeded the detection limits, given at As 12.40-24.60 mg/kg. For most metals, the presence of heavy metals in multiple classes of particle sizes showed greater accumulations in fractions of fine-scale. The finest fractions 0.075 mm had the highest concentration of all-metal study. These findings agree with research on preferential separating of metals in sediments to fractions of fine particle size (Ljung *et al.*, 2006). The metals contained in fine particles such as Smectite, Vermiculite, and organic matter depend on high surface areas, and especially 2:1 expanding forms of clay minerals have negative loads associated with fine particles. The large quantities (20-35%) of dolomite and calcite in fine particle size fractions of Iraqi sediments will, however, serve as big metal sinks. Metals such as Pb and Zn react readily to form metal-carbonate complex/minerals with CO_3^{-2} on the surface of dolomitic or calcite crystals Hassan *et al.*, (2008) recorded that the carbonate fraction metals in the Basra South Iraq sediment type are as follows: 33% Cd, 16% Pb, 5%Zn and 1% Cr.

Contaminant Factor of heavy metal (C.F)

Vanadium (V) has been rather consistently distributed in sediment profiles and the difference in V concentration of sediment is genetic from the parent material. Maximum concentrations of V (up to 500 mg/kg) are therefore described for Cambisols, often sediments resulting from mafic rocks. The lowest concentration of V (up to 150 mg/kg) was in peat sediments.(Kabata-Pendias, 2010).

Table 10. Mean of I-geo of heavy metal in selected fraction sediments sample

Stations	Sieve (mm)	Al	As	Cd	Cu	Fe	Mn	Ni	Pb	V
ST1	0.075	2.89	2.20	-1.68	3.54	2.61	-1.61	2.16	2.46	-0.53
	0.15	2.81	1.65	-2.49	2.45	2.53	-2.77	0.50	2.34	-2.40
	0.355	2.79	0.45	0.00	0.87	2.43	-3.32	-0.02	2.15	-3.60
ST5	0.075	3.56	1.37	-1.91	2.45	2.59	-1.87	1.43	4.59	-1.95
	0.15	2.95	1.31	0.00	2.13	2.58	-2.09	1.36	4.36	-2.14
	0.355	1.91	1.22	0.00	1.50	2.54	-2.52	0.68	2.51	-2.97
ST7	0.075	4.26	1.05	-1.91	3.26	2.60	-1.94	1.56	4.79	-1.89
	0.15	4.14	0.92	0.00	0.40	2.37	-3.60	-0.43	2.81	-2.19
	0.355	1.46	-0.67	0.00	0.26	2.37	-3.76	-0.53	2.30	-2.82
ST10	0.075	3.98	1.74	-2.17	0.76	2.41	-3.21	-0.18	3.11	-1.91
	0.15	1.17	1.74	-2.91	-0.46	2.27	-4.36	-1.33	3.25	-2.88
	0.355	0.94	-0.36	-3.49	-1.40	2.18	-4.84	-2.03	2.38	-2.91
Average		3.12	1.25	-3.03	1.95	2.46	-2.68	0.71	3.42	-2.13
Min		0.94	-0.67	0.00	-1.40	2.18	-4.84	-2.03	2.15	-3.60
Max		4.26	2.20	-1.68	3.54	2.61	-1.61	2.16	4.79	-0.53

Metal enrichment factors (E.F)

Al E.F's height value is a result of its dominance as well as its concentration increase compared with other elements in the earth's crust (8%), equivalent to 800 mg/kg (Kabata-Pendias, 2010). This indicates that the studied stations ranged from non-polluted to low pollution with Cu according to this criterion. The results of the study suggested that the values of E.F. Pb ranged between 0.84 to 2.73, representing that the stations under study ranged from no enrichment to minor enrichment in Pb. The reason for this may be that the stations studied are marine sites of activity for ships and maritime carriers in oil loading and unloading positions or they may be close to seaports or a waste disposal area, and it is possible that air pollution has a large role in this steady increase in the concentration of lead and thus increase in pollution rates it according to the total concentration of the studied samples strongly affected by anthropogenic activities. This is in agreement with the findings of many studies Al-Khuzaie, (2015); Al-Khuzie *et al.*, (2017), and Abdulnabi *et al.*, (2019) as their study indicated that the Iraqi tidal surfaces were contaminated with Pb when they used the same standard.

These metals may have derived or suggested anthropogenic ally initiated metal depositions from dust and exhausts of trucks. This result agrees with Al-Jaberi *et al.*, (2016); Al-Khuzie *et al.*, (2017) and Hassan, (2018) who used an E.F. as a measure of substantial human-induced metal accumulation in coastal flat sediment of Iraqi costs.Long-distance transport and fertilizers applied to plants are other possible sources of metals, as suggested in previous reports(Holmgren *et al.*, 1993; Kabata-Pendias and Pendias, 2001; Varrica *et al.*, 2003). The application of sewage sludge as fertilizer was attributed to Ni and Cu in tidal flat sediments (Al-Saad *et al.*, 2006). Other authors, however, reported pollution in this region with Cd, Pb, Ni, relying on E.F but using Fe for the background element (Abdulnabi *et al.*, 2019; Al-Khuzaie, 2015; Al-Khuzie *et al.*, 2017; Hassan, 2018).

Metal Geo accumulation Index (I-geo)

The results indicated that the sediments within this volume were contaminated with Al, As, Fe, and Pb, while they were uncontaminated with the elements Cd, Cu, Mn, Ni, V and the degrees of contamination differed according to this criterion. The Aluminum element is one of the elements that are the most dominant due to its high abundance in the earth's crust, as it reaches 8%. The Fe were behaving similarly to Al when calculating this parameter, and for the same reasons if the earth's crust content of Fe is 5%(Kabata-Pendias, 2010). As I-geo, calculated based on the concentration of elements in sediment grains, it has been shown that the finest grains 0.075 mm are the highest values compared to other grains for this standard and all elements. This indicates that the studied stations were polluted with As according to this criterion and it varied from moderate pollution to polluted this agreement with (Abdulnabi *et al.*, 2019). This coefficient followed the same behavior for all the studied elements when adopting the concentration in the granules. The I-geo parameter was the most accurate of E.F in assessing the state of pollution since the first gives a direct description of the pollution to the concentration of the metal in the sample and attributes it to the concentration of the metal in the earth's crust, while the second relates the concentration of the metal in the sample to another element within the more dominant metals in the earth's crust like Al, Mn, and Fe.Fe concentration was used in this study when calculating E.F(Al-Khuzie *et al.*, 2017; Hassan, 2018).

Conclusion

The concentration of metals in sediments increases with decreasing particle size as shown in this study. Most of the coastline sediments are muddy sand to sand. This advises that the sediments were precipitated under low energy conditions, as sediments ordinarily become rougher with the increase in energy of the transferring medium. The finest fractions 0.075 mm had the highest concentration of all-metal study as a flow : Al > Fe > Mn > V> As>Pb> Cu > Ni > Cd. In bulk sediment and Al > Fe > Mn > V> Cu> As > Pb > Ni > Cd. Infractions sediment. Decreasing quantities of selected heavy metals with increasing particle size were indicated by the following coefficients of determination. Ni> Cu> Fe>Mn> V> As> Al> Cd. The E.F in the 0.075 mm fraction of the following elements in all sediment in the study area were less than 1 Cd, Mn, V, while Ni, Cu except ST8 0.355 mm it was 1.075, 1.43 respectively. In addition, EFs for Pb in the finest fraction were in 0.15 ST 5 it reached 2.6. The high E.F values (ST.5) for Pb (in 0.15 mm) and ST8 for Ni (in 0.355) fractions exceeded 2.0mm.

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