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Metals Pollution in Marine Sediments of the United Arab Emirates Creeks Along the Arabian Gulf Shoreline

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The study of trace metals in the marine environment of the United Arab Emirates is very important since coastal regions are presently experiencing a phenomenal rate of growth in terms of industrial and urban development. Special emphasis is given to enclosed areas and creeks due to the vastness of these parts of the country's waters, their richness in marine life. and the difficulty of combating pollution that may reach these areas. These creeks are used as harbors for hundreds of fishers and cargo boats. They receive intermittent and variable amounts of municipal wastewaters from many outlets in addition to various pollutants from many other wooden huts. dry docking companies, petrol filling stations, repair and storage yeards.

The primary objective of this paper was to identify pollution levels and distributions of several trace metals in five different creeks sediments of the United Arab Emirates along the Arabian Gulf.

MATERIALS AND METHODS

Sediment samples were collected from five different creeks along the Arabian Gulf Coast of the United Arab Emirates using a Hydro-Bios grap sampler (Fig. 1). Grain size distributions were done using a standard set of stainless steel sieves and electric shaker.

Trace metals analyses were done by treating the sample with hydrogen peroxide and diluted hydrochloric acid (Agemian. Chau 1976; Van Valian , Morse 1982). Measurements were carried out in duplicate by direct aspiration into the appropriate flame of a GBC model 906 atomic absorption spectrophotometr equipped with a simultaneous background corrector. autosampler and recorder. Duplicates, spikes and blanks were treated identically using the same reagents to test for precision, accuracy,
and reagent's purity in the analytical procedure. respectively. Percentage recovery for spiked samples ranged from 96 to 105 %. while precision agreed within 5 %.

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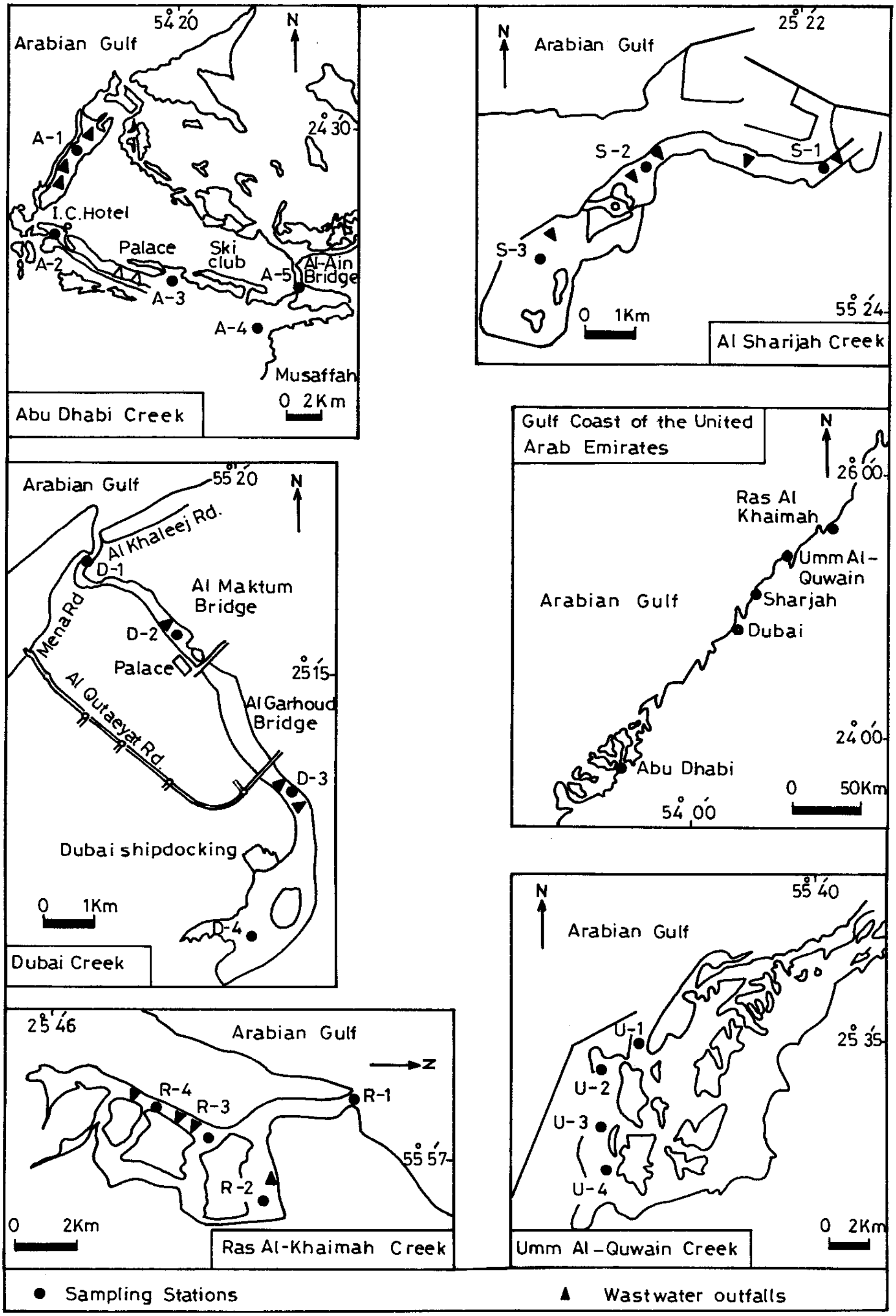

Figure l. The Gulf coast of the United Arab Emirates and locations of sampling stations

Blank values were almost negligible.

Organic carbon percentages were determined using acid dichromate and blank titration method as described by Gaudette et al. (1974).

RESULTS AND DISCUSSION

It has been stated (Agemain and Chau, 1976) that metals in sediments may be classified as those which arc lattice-held, i.e., residual, and non-lattice held. i.e., non-residual. Non-residual metals are not part of the silicate matrix and have been incorporated into the sediment from aqueous solutions by processes such as adsorption and organic complexation. Thus, non-residual metals include those originating from polluted waters, and the present study involved the quantification of this fraction.

The concentrations ($\mu g.g^{-1}$) of trace metals (Table 1) showed wide variations that were probably due to type, composition, grain size, organic carbon contents, physicochemical characteristics of the overlying water layers, anthropogenic inputs such as geological weathering. spilled crude oil, atmospheric fallout, waste-waters disposals. Variations between different stations at different creeks were more pronounced at Sharjah creek. The outer station (S-1) of Sharjah creek showed the lowest concentrations ($\mu g.g^{-1}$) of meta1s,*i.e.*, Cd (6.48), Co (11.78), Cr (11.75), Cu (18.04), Mn (80.29), Ni (33.81), Pb (15), and Zn (157) among all other stations. Most metals, particularly zinc showed a common trend of increase towards inner-most parts of the creek where they receive increasing quantities of municipal and industrial waste-waters from many outlets as well as from fishermen and cargo boats. Pollutants from many other sources such as petrol filling stations, wooden huts. repair and storage yards seem to contribute also strongly to the processes of metals accumulation in sediments. Among all other creeks; sediments of Sharjah creek contained the highest metals concentrations of cobalt (12.84 $\mu g.g^{-1}$), chromium (18.75 $\mu g.g^{-1}$), copper (29.33 $\mu g.g^{-1}$), lead (43.61 $\mu g.g^{-1}$), and zinc (300.3 $\mu g.g^{-1}$) due to the disposal of municipal waste-waters and different wastes from boats. fuel stations, repair and storage yards, wooden huts. Manganese showed high levels in sediments of Dubai, Sharjah and Abu Dhabi creeks that are most likely related to the microbial degradation of organic materials leading to a rapid removal of metal adsorbed to the surfaces of clays and detritus particles (Presley et al.. 1973) and/or geological nature of the sediments.

Organic carbon contents, on the other hand, showed wide ranges of variations (0.06-2.28 %) with considerable accumulation in inner-most parts of Sharjah (2.28 %), and Dubai (1.69 %) creeks (Table 1). The semi-enclosed nature, limited water currents in the inner-most parts. and the slow rate of water exchange with coastal water tend to enhance conditions suitable for the accumulation of organic materials within these areas.

Table 1. Ranges and mean values (± SD) of trace metals ($\mu g.g^{-1}$) and percentages of organic carbon in marine sediments.

Area	Abu-Dhabi	Dubai	Sharjah	Umm al-Quwain	Ras al-Khaimah
Trace Metals	Range Mean± SD	Range Mean ± SD	Range Mean ± SD	Range Mean± SD	Range Mean ± SD
Cd	4.8- 6.9	4.5- 6.4	4.9- 9.6	4.8- 6.9	4.3- 5.7
	5.9± 0.5	5.3± 0.4	5.7± 1.2	5.8± 0.6	5.0± 0.5
Co	6.0- 12.1	5.0- 12.0	8.9- 25.9	9.3- 1.0	8.1- 12.0
	10.7± 1.4	10.4± 0.8	12.8± 4.7	10.5±1.2	9.9± 1.1
Cr	6.3- 22.0	5.0- 18.1	7.1-30.0	5.0- 15.0	6.1- 11.9
	10.7± 4.0	10.8± 4.6	18.8± 8.2	9.1± 3.2	8.6± 1.7
Cu	4.0- 44.9	3.1- 46.9	9.9-48.0	4.3 -79.0	5.0- 68.0
	3.5± 10.4	3.8±11.0	29.3±13.2	18.2±18.3	16.9±17.4
Mn	11.8- 240.0	17.3-352.9	10.1-177.0	11.0-173.0	5.0-148.0
	112.7±68.2	116.9±95.0	110.1±46.5	82.4±56.6	61.1± 47.9
Ni	13.9- 99.0	11.0-241.5	8.0-28.0	14.0- 22.0	12.0 - 30.7
	2.4±36.3	27.2±49.0	20.6± 5.4	17.1± 2.3	17.8± 4.9
Pb	9.0- 8.1	21.0 - 43.9	10.3-57.0	16.20-32.0	23.1- 30.9
	23.8± 4.4	28.1± 4.9	43.6±12.8	25.4± 4.3	26.3± 2.3
Zn	3.0- 0.9	15.0-109.0	141.0-534.0	5.2- 48.6	6.0- 27.0
	10.9± 5.4	42.1±24.0	300.3±125	18.7±10.6	13.6± 6.0
OC	0.13-1.32	0.60-1.9	0.42- 2.28	0.6- 1.3	0.1- 1.8
	0.64± 0.4	0.73±0.6	1.6± 0.5	0.5± 0.4	0.8± 0.6

Investigations of relationships (Fig. 2) between different metals revealed the presence of strong and significant correlations (p= 0.001) between several couples. This suggests that the appearance of high concentrations of zinc as a result of the waste-water disposal has accompanied by an increase in the levels of some other metals such as chromium, copper, and lead. The appearance of high concentrations of lead is also correlated with the high levels of chromium and copper. Investigations of relationships between metals and organic materials indicated also the presence of positive correlations (p=0.01). This finding reveals that complexation of these metals with organic materials plays an important role in their distribution patterns (Samual and Phillips, 1988).

It has been reported (Nicholsen and Moore, 1981) that a major portion of metals input enters the marine systems in the form of metal-rich finally divided particulate matter which precipitates on encountering high electrolyte concentrations in a major portion of metals input enters the marine systems in the form of metal-rich finally divided particulate matter which precipitates on encountering high electrolyte concentrations in relatively slow-moving water,

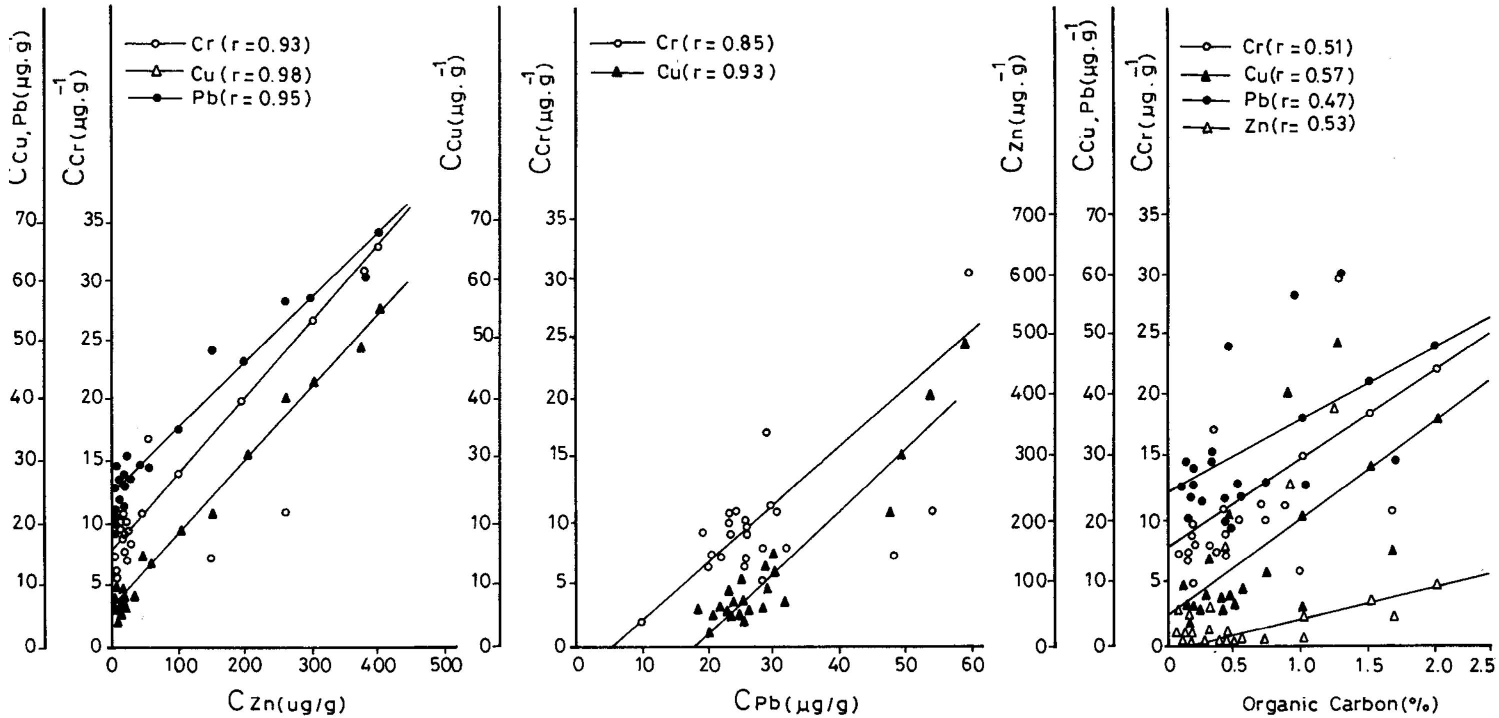

Figure 2. Releationships between different metals as well as between different metals and Organic Carbon (%) in marine sediments

higher metals concentrations and higher organic carbon contents were measured in the grain-size fraction less than 63 μm as compared with other fractions studied here (Fig. 3).

Comparing the present results with those published in the literature (Table 2) for adjoining marine environments. it is concluded that the levels reported by most workers for chromium, copper, manganese, and nickel are higher than the present levels. Whereas, their levels for cadmium. cobalt, and zinc are lower. It is

Table 2. Comparison of the present levels of trace metals ($\mu g.g^{-1}$) with reported levels for adjoining marine environments.

Trace Metals	References				
	1	2	3	4	5
Cd	4.32 - 9.55 (5.54)	0 - 0.12 (0.03)	1.46 - 2.54	0.14- 0.23	0.1 -1.0 (0.26)
Co	6.01-25.93 (10.88)	0 - 3.40 (0.73)	ND	ND	1.0 - 3.0 (2.01)
Cr	4.96-30.0 (11.57)	1.4- 26.20 (10.4)	38.0 - 96.0	70.9-114.2	ND
Cu	3.05-79.0 (18.34)	1.8- 43.0 (9.7)	14.0 - 30.0	17.3- 37.1	1.5 - 5.3 (2.59)
Mn	5.03-352.0 (96.62)	12.2-176.0 (88.8)	216 - 528	915 - 1643	35 - 78 (51.5)
Ni	8.01-214.5 (27.0)	0.4- 35.40 (9.0)	36.0 - 102	386 - 637	5 - 14 (10.1)
Pb	9.03-57.01 (29.42)	0 - 35.40 (6.06)	2.5 - 35	5.6 - 25.6	3 - 6 (3.55)
Zn	3.01-534.0 (77.10)	0.4-142.0 (31.2)	27 - 75	27.0 - 43.0	8 - 28 (13.7)

ND: Not determined
1. Present study (Coastal U. A. E., Arabian Gulf).
2. Abu-Hilal and Khardgui , 1992. (Coastal U. A. E., Arabian Gulf).
3. Salman *etal.* 1987. (Kuwait, Arabian Gulf).
4. Abayachi and DouAbul, 1986 (The Arabian Gulf).
5. Al-Hashimi, Salman, 1985. (Iraq, Arabian Gulf).

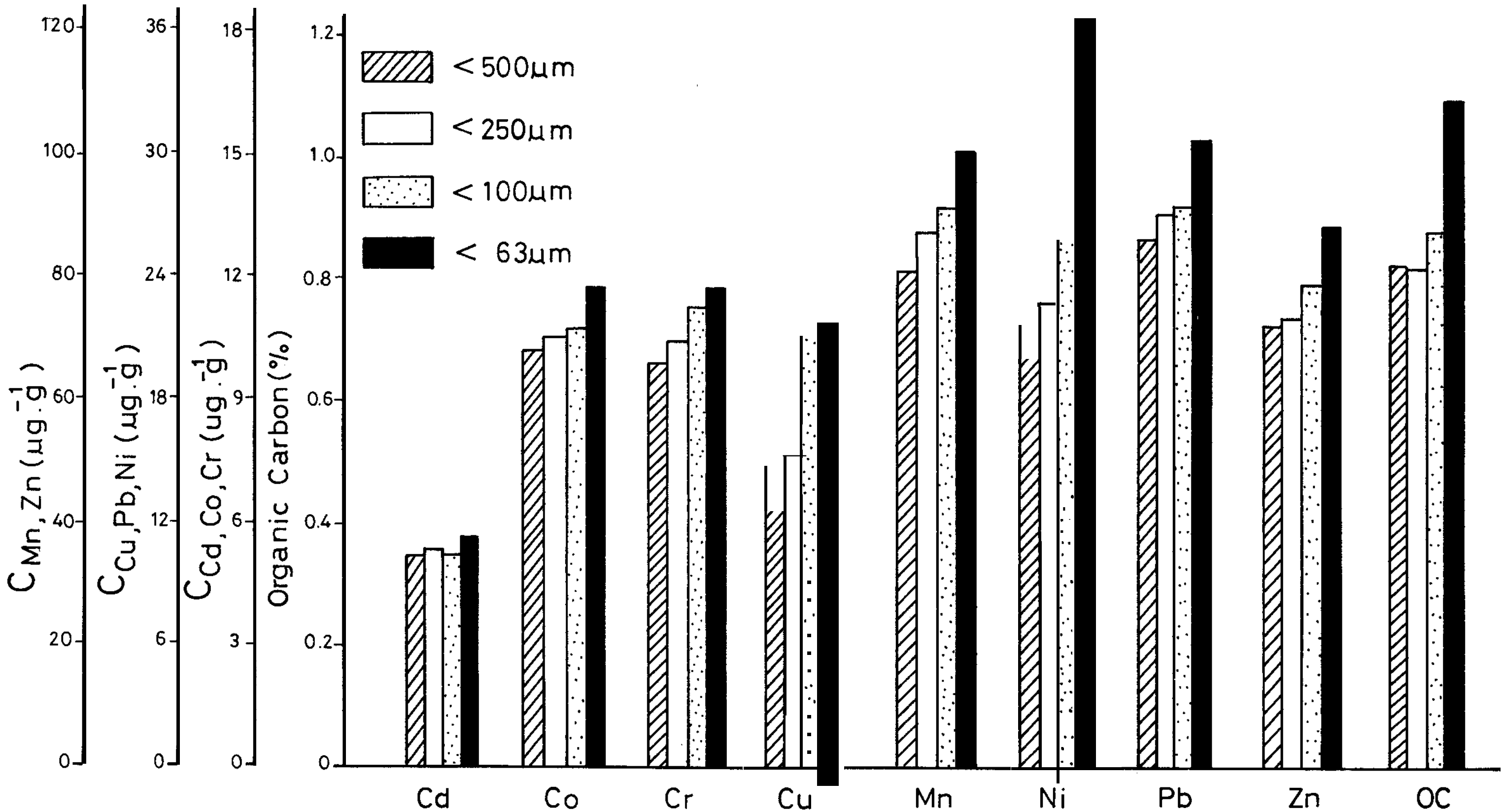

Figure 3. The average values of trace metals and Organic Carbon in different grain size fractions of sedemints.

important to mention here that the type, composition, grain-size of sediments. strength of the digestion or extraction method used are among other factors behind such differences. A direct comparison between present levels with those of Abu-Hilal and Khardgui (1992) clears out that the continuos discharge of industrial and domestic waste-waters inside the creeks has elevated the levels of metals and contents of organic materials. It is therefore, strongly recommended to minimize the discharged loads of trace metals and other organic pollutants into these fragile ecosystems.

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