GEOCHEMISTRY OF A CORE SEDIMENT OFF BUSHEHR, PERSIAN GULF

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ABSTRACT
In the present study, the geochemistry of a sediment core is investigated. The concentrations of various heavy metals at different sections of a sediment core from the Persian Gulf is clearly indicative of two important evidents (Norooz Oil Field incident and Kuwait's oil fields damage) that has lead to sever pollution. The sources of trace elements (Cu, Zn, Pb, Ni, Cr, Mn) have been investigated by the method of cluster analysis as well as chemical partitioning techniques. Based on the above mentioned incidents that are recorded in 54 cm sediment core, we report approximately 2 cm/yr as the sedimentation rate off Bushehr. The results of partition studies has revealed the anthropogenic distribution of metals as: Mn (46%)> pb (40%)>Cu (18%)> Zn (12.8%)> Fe (2.4%). Finally, the concentration of studied metals are compared with those of Mean Crust and Mean world Sediments.

RÉSUMÉ
In the present study, the geochemistry of a sediment core is investigated. The concentrations of various heavy metals at different sections of a sediment core from the Persian Gulf is clearly indicative of two important evidents (Norooz Oil Field incident and Kuwait's oil fields damage) that has lead to sever pollution. The sources of trace elements (Cu, Zn, Pb, Ni, Cr, Mn) have been investigated by the method of cluster analysis as well as chemical partitioning techniques. Based on the above mentioned incidents that are recorded in 54 cm sediment core, we report approximately 2 cm/yr as the sedimentation rate off Bushehr. The results of partition studies has revealed the anthropogenic distribution of metals as: Mn (46%)> pb (40%)>Cu (18%)> Zn (12.8%)> Fe (2.4%). Finally, the concentration of studied metals are compared with those of Mean Crust and Mean world Sediments.

1. INTRODUCTION

The occurrence of elevated levels of trace metals especially in the sediments can be a good indication of man-induced pollution and high levels of heavy metals can often be attributed to anthropogenic influences, rather than natural enrichment of the sediment by geological weathering (Davies et al., 1991; Lord and Thompson, 1988). There can be significant temporal and spatial variability in water column concentrations of heavy metal contaminants, which leads to problems in obtaining representative samples. Sediments, on the other hand, integrate contaminants over time and are in constant flux with the overlying water column. The analysis of heavy metals in the sediments permits detection of pollutants that may be either absent or low concentrations in the water column (Davies et al., 1991), and their distribution in coastal sediments provides a record of the spatial and temporal history of pollution in a particular region or ecosystem. Heavy metal concentrations in the water column can be relatively low, but the concentrations in the sediment may be elevated. Low level discharges of a contaminant may meet the water quality criteria, but long-term partitioning to the sediments could result in the accumulation of high loads of pollutants (Martin and Whitfield, 1983).

Once heavy metals are discharged into coastal waters, the rapidly become associated with particulates and are incorporated in bottom sediments (Hanson et al., 1993). The accumulation of metals from the overlying water to the sediment is dependent on a number of external environmental factors such as PH, Eh, ionic strength,anthropogenic input, the type and concentration of organic and inorganic ligands and the available surface area for adsorption caused by the variation in grain size distribution (Davies et al., 1991).

The objectives of this paper are to determine the origin, distribution and levels of sediment contamination by heavy metals in Persian Gulf, Bushehr.

2. MATERIAL AND METHODS

One 4 cm diameter gravity core was collected in March 1995 at the station located at 28º 58' latitude and 50º 43' longitude. The core was stored vertically at 4° C and sampled at 1cm intervals in the laboratory.

The samples were freeze dried and 0.5 g of each sample, in triplicate , were placed in Teflon beakers containing 10 ml cHNO3. The mixture was heated to near dryness and allowed to cool before 7 ml of c HF was added. Then the mixture was heated to near dryness and allowed to cool. 10 ml of Aqua Regia was added to each sample and heated to near dryness. The samples were allowed to cool to room temperature and were then filtered. The filtrates were transferred to 50 ml volumetric flasks and made up to mark with 1N HCl. The metal determinations of the solutions were performed on a PYE UNICAM atomic absorption spectrometer using the calibration curve method. The samples were analyzed for Ni, Cu, Cr, Pb, Mn, Fe, Zn, Al, Ca.

Partition chemical analysis was done according to the method described by Basaham and AI- Lihaibi (1993). 1 gr of each dry samples were taken in 250 ml Erlenmeyer flasks, and add 10 ml 0.53 N HCl. A PYE UNICAM atomic absorption spectrometer was used for the measurement of trace element concentrations. Duplicate measurements were made for each sample. The accuracy and precision of the atomic absorption analyses and the possible loss of trace elements during the digestion steps was checked by the use of marine sediment standard MESS-1 (Table 1).

3. RESULTS AND DISCUSSION

The results of heavy metal analysis are shown in Table 2. High concentrations of Cu, Pb, Cr, Zn, Ni were found at depths of 8 cm and 26 cm. The highest concentrations of Ca, Fe and Al were measured at depth of 7 cm. Mn showed the highest value at depth of 5 cm.

The data in Table 3 and Fig. 1 show anthropogenic sources of Cu, Pb, Cr, Zn, Ni. Also increases in concentrations of these heavy metals and LO levels at depths of 8 cm and 26 cm indicate severe pollution caused by two important evidents, Gulf war oil spill (1991) and Norooz Oil Field incident (1983), respectively. Furthermore high loads of Fe and Ca at depth of 7 cm reveal the destruction of marine life after oil spill 1991.

The results of partition chemical analysis are given in Table 4. It reveals the anthropogenic distribution of metals as:

Mn(46%) > Pb(40%) > Cu(18%) > Zn(12.8%) > Fe(2.4%)

Besides, the mean concentrations of Ni, Pb, Cr, and Ca are higher than their contents in Mean Crust and Mean World Sediments (Table 5).

Table 1. Analytical results of MESS-1

Element	MESS-1	This Study
Mn (ppm)	513 ± 25	488.7± 2.4
Ni (ppm)	29.5 ± 2.7	29.7± 0.359
Zn (ppm)	191± 17	183.3 ± 1.011
Cu (ppm)	25.1± 3.8	26.0 ± 0.001
Pb (ppm)	34± 6.1	41.7 ± 1.76
Cr (ppm)	71 ± 11	60.5 0.82
Fe (%)	3.1± 0.25	3.13 0.007
Al (%)	5.84 ± 0.38	5.8 0.006
Ca (%)	0.481± 0.064	0.447 0.002

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Table 2. Metal concentrations in sediment core

Depth (cm)	Cu (ppm)	Pb (ppm)	Cr (ppm)	Zn (ppm)	Ni (ppm)	Mn (ppm)	Fe (%)	Al (%)	Ca (%)	LOI (%)
0-1	22.4	43.9	127.1	63.0	108.9	458.7	2.6	4.17	14.87	25.60
1-2	19.4	46.1	122.8	59.7	106.1	466.5	2.5	3.97	13.62	24.25
2-3	22.8	66.6	143.8	59.0	130.8	480.6	2.6	3.71	15.47	23.70
3-4	23.6	47.6	130.4	52.7	110.0	487.6	2.4	4.29	14.60	17.40
4-5	18.0	34.4	123.5	49.4	110.7	513.6	2.6	3.65	11.52	22.90
5-6	19.3	38.4	144.6	49.4	103.4	506.2	2.9	3.72	12.70	24.20
6-7	21.4	51.7	166.2	46.1	105.2	490.6	2.6	5.27	19.19	23.40
7-8	31.5	80.6	181.9	65.9	99.2	466.7	2.5	4.67	16.24	25.70
8-9	20.1	57.6	109.2	43.3	106.2	443.1	2.8	4.66	17.10	23.80
9-10	23.2	43.7	140.9	44.9	102.4	459.6	2.4	4.30	15.50	22.45
10-11	20.3	45.2	126.2	46.6	106.3	456.9	2.4	3.48	13.50	19.90
11-12	19.42	41.7	136.5	43.6	100.6	432.4	2.5	3.48	12.95	23.20
12-13	21.0	41.4	124.5	50.5	102.7	445.4	2.4	3.59	14.64	22.90
13-14	20.3	37.9	125.7	50.1	103.2	438.1	2.4	4.40	12.28	19.25
14-15	20.3	33.5	114.9	52.8	103.9	441.8	2.5	4.83	13.30	24.00
15-16	19.1	38.7	125.8	51.8	102.8	449.6	2.5	5.01	14.30	23.40
16-17	18.4	43.4	121.6	52.2	103.2	455.7	2.3	5.12	16.15	24.00
17-18	20.4	42.7	117.0	52.5	113.6	447.5	2.7	5.00	12.38	24.40
18-19	21.1	36.5	145.2	53.8	112.0	437.7	2.7	5.20	15.83	23.70
19-20	22.4	44.0	124.2	48.5	101.1	472.3	2.7	5.20	15.90	23.20
20-21	17.5	39.0	140.2	46.6	96.7	421.6	2.5	4.70	14.60	22.40
21-22	15.8	44.0	133.0	48.8	97.81	402.1	2.5	4.70	2.30	23.60
22-23	20.1	44.0	118.4	49.5	100.6	419.4	2.6	4.80	14.44	24.10
23-24	16.9	45.7	109.6	43.0	100.2	430.9	2.4	4.70	13.88	18.80
24-25	18.3	41.8	106.8	46.0	97.8	402.8	2.4	4.40	14.70	24.00
25-26	31.0	48.2	160.5	65.2	133.4	419.7	2.7	5.20	15.56	24.10
26-27	18.4	38.3	125.4	47.8	107.1	448.5	2.5	4.30	13.48	24.40
27-28	21.8	46.3	132.8	34.9	117.4	509.2	2.6	4.70	15.44	22.30
28-29	20.6	38.8	128.9	34.2	106.9	479.5	2.7	4.50	15.30	24.20
29-30	22.0	36.3	139.6	34.6	102.8	486.0	2.7	4.30	15.17	24.20
31-33	18.9	33.5	123.3	36.0	103.4	472.7	2.6	4.30	14.48	23.90
34-36	21.2	39.9	139.6	36.3	112.2	484.4	2.6	4.50	15.50	23.90
37-39	19.5	39.7	124.4	34.9	98.0	473.3	2.5	4.40	13.50	23.40
40-44	19.5	37.9	118.2	29.7	103.8	459.5	2.2	4.40	11.15	24.00
45-49	24.8	64.0	118.5	44.5	95.8	455.4	2.2	2.90	11.96	24.20
50-54	24.1	53.3	126.2	49.1	101.1	446.6	2.2	2.07	9.35	24.00
Min.	15.8	33.5	106.8	34.2	96.7	402.1	2.2	2.07	9.35	17.40
Max.	31.5	80.6	181.9	65.9	133.4	513.6	2.92	5.27	19.19	25.70
Mean	20.97	44.6	130.5	47.7	105.7	457.3	2.52	4.35	14.24	23.24
S.D.	3.22	9.72	15.69	8.74	8.16	27.73	0.16	0.68	1.84	1.76

Table 3. Correlation coefficients

Element	Cu	Mn	Ni	Pb	Zn	Cr	Fe	Al	Ca	LOI
Cu	1.000	0.128	0.283	0.634	0.442	0.613	0.244	-0.052	0.233	0.183
Mn	0.128	1.000	0.240	0.027	-0.232	0.246	0.331	-0.145	0.148	-0.015
Ni	0.283	0.240	1.000	0.120	0.320	0.289	0.322	0.150	0.226	0.027
Pb	0.634	0.027	0.120	1.000	0.411	0.410	0.044	-0.186	0.234	0.140
Zn	0.442	-0.232	0.320	0.411	1.000	0.336	0.122	0.062	0.101	0.130
Cr	0.613	0.246	0.289	0.410	0.336	1.000	0.595	0.162	0.419	0.191
Fe	0.244	0.331	0.322	0.044	0.122	0.595	1.000	0.498	0.812	0.084
Al	-0.052	-0.145	0.150	-0.186	0.062	0.162	0.498	1.000	0.616	0.031
Ca	0.233	0.148	0.226	0.234	0.101	0.419	0.812	0.616	1.000	0.080
LOI	0.183	-0.015	0.027	0.140	0.130	0.191	0.084	0.031	0.080	1.000

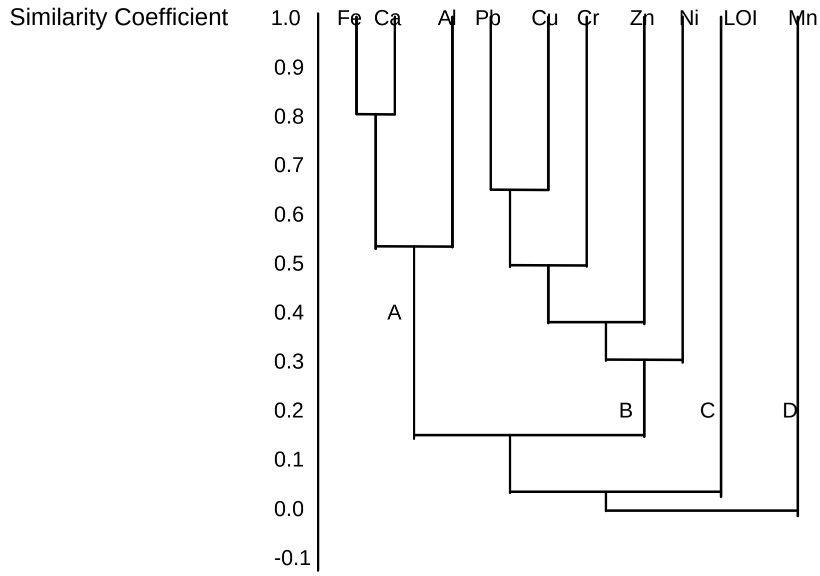

Figure 1. Cluster analysis

Table 4. Partition chemical analysis of sediment core

Depth (cm)	Cu (ppm)	Pb (ppm)	Cr (ppm)	Zn (ppm)	Ni (ppm)	Mn (ppm)	Fe (%)
0-1	4.29	18.47	0.035	17.24	0.031	224.6	0.08
1-2	3.44	18.49	0.035	7.13	0.031	212.1	0.08
2-3	3.33	17.92	0.035	5.12	0.031	210.9	0.07
3-4	4.88	18.56	0.035	8.15	0.031	206.6	0.08
4-5	3.27	17.59	0.035	3.03	0.031	194.8	0.05
6-7	4.97	17.84	0.035	5.09	0.031	219.1	0.08
8-9	2.70	16.64	0.035	4.08	0.031	203.1	0.06
10-11	3.47	18.69	0.035	5.84	0.031	213.5	0.06
13-14	3.12	16.81	0.035	4.46	0.031	187.6	0.05
16-17	4.22	18.18	0.035	6.28	0.031	208.2	0.06
20-21	3.85	17.45	0.035	5.102	0.031	210.1	0.07
24-25	3.42	18.43	0.035	4.405	0.031	217.8	0.08
29-30	4.27	18.38	0.035	16.90	0.031	211.3	0.07
34-35	3.97	17.99	0.035	3.46	0.031	209.9	0.06
39-40	3.58	17.15	0.035	3.29	0.031	208.9	0.05
44-45	3.35	18.04	0.035	2.38	0.031	215.4	0.04
49-50	3.60	17.25	0.035	3.77	0.031	208.8	0.06
53-54	4.19	18.08	0.035	4.19	0.031	216.3	0.05
Mean	3.72	17.88	0.035	6.10	0.031	209.9	0.06

Table 5. Metal concentrations of Mean Crust, Mean World Sediment and sediment core of this study

Element	Mean Crust	Mean World Sediments	Mean Sediment Core*
Cu (ppm)	50	33	28.50
Pb (ppm)	14	19	60.64
Cr (ppm)	100	---	177.28
Zn (ppm)	75	95	64.74
Ni (ppm)	80	52	143.55
Mn (ppm)	950	770	620.35
Fe (%)	4.10	4.10	3.44
Al (%)	8.20	7.20	5.93
Ca (%)	4.10	6.60	14.24

*CaCo3-free basis