Mahasagar-Bulletin of the National Institute of Oceanography, 19 (1), 1986, 39-44

DISTRIBUTION OF HEAVY METALS AND ORGANIC CARBON IN SEDIMENTS OFF MADRAS AND VISAKHAPATNAM

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ABSTRACT

Distribution of Fe, Cu, Mn, Zn, Hg and organic carbon in continental shelf sediments off Madras-Visakhapatnam was studied during the RV *Gaveshani* cruise 127 and 128 in November-December 1983. Among the 11 stations studied, heavy metal concentrations varied between stations and the results revealed higher values of heavy metals and organic carbon in sediments collected north off Madras than the values obtained for samples collected north off Visakhapatnam.

Key-words : Heavy metals, organic carbon, sediments, Bay of Bengal.

The chemical nature of bottom sediments and organic matter associated with sediments, play a major role in the cycling and concentration of many elements in the oceans. Fairly large amounts of trace metals are introduced into the ocean from the sources such as mining and metallurgical operations, industrial wastes (Hershelman, Schafer, Jan and Young, 1981; Wa'dichuk, 1974; Zingde and Desai, 1981), weathering of rocks and subsequent land run off during precipitation and agricultural drainage (Kumaraguru, 1980). All these may result in high levels of heavy metal concentration in the marine environment. Bay of Bengal receives many kinds of pollutants through various sources. Studies on heavy metal and organic carbon concentration would reveal the extent to which these pollutants get distributed in the sediments of Bay of Bengal off two industrialized cities viz. Madras and Visakhapatnam.

The present study was undertaken, since the coastal waters off Madras and Visakhapatnam are subjected to pollution due to variety of pollutants like the heavy metals namely Fe, Mn, Cu, Zn and Hg and organic carbon. Hence it seemed worthwhile to make an exploratory survey of heavy metals along the coast and continental shelf sediments of Bay of Bengal.

Sediment samples were collected from 7 stations during cruise 127 and from 4 stations during cruise 128 of R.V *Gaveshani* in November-December 1983. The 7 stations sampled during cruise 127 lie north off Madras along the coast whereas the other 4 stations sampled during cruise 128 lie north off Visakhapatnam (Fig. 1). Samples were collected using a vertical gravity corer, and then the sediment for various analyses was taken from the mid part of the core to avoid

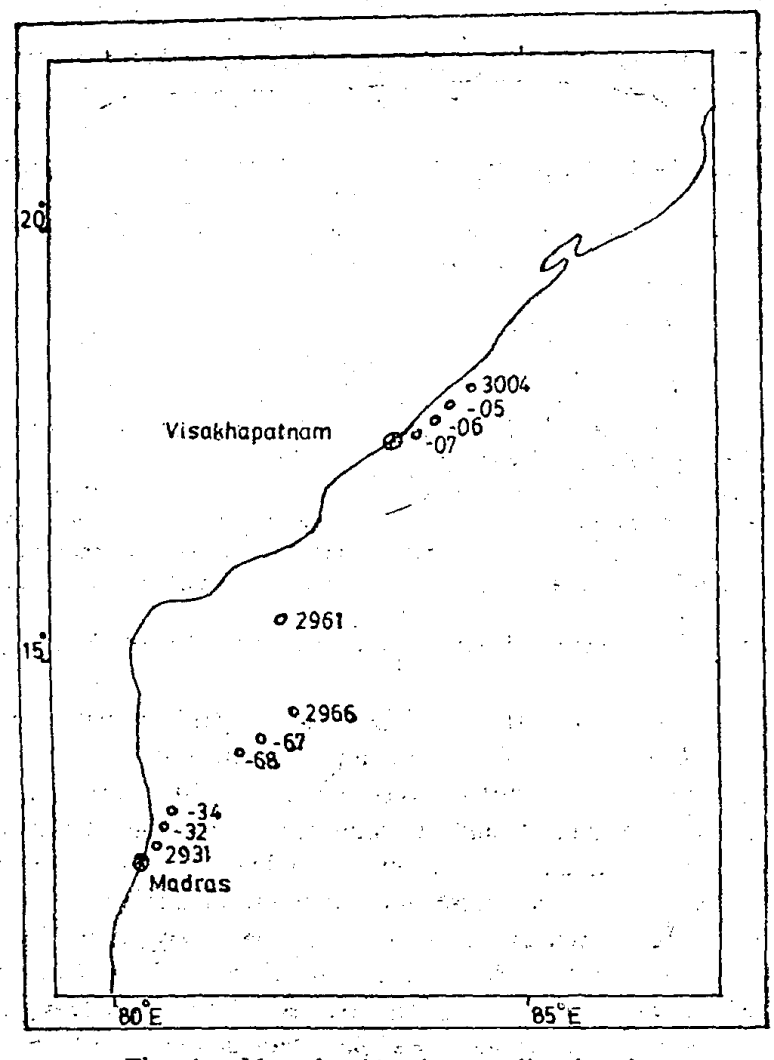

Fig. 1. Map showing the sampling locations.

metal contamination by the corer. The samples were washed with distilled water (for organic carbon estimation), oven dried and powdered. One gram of powdered sediment was taken for the analysis of trace metal (Fe, Zn, Cu and Mn). The samples were digested by the hot acid digestion method of Smith and Windom (1972). After complete evaporation of the acids, the final residue was dissolved in 10 ml of 2 N HCl and filtered through acid treated Whatman No. 40 filter paper. The filtered solution was made upto 100 ml with double distilled water. The trace metals Fe, Mn, Zn, and Cu were analysed using Perkin Elmer 2280 AAS with adequate number of standards for the calibration of the instrument. The precision and the detection limit of the instrument is ± 0.01 µg.

Separate digestion procedure was adopted for mercury analysis due to its highly volatile nature. The sediment was digested following the method of Topping and Holden (1978). After digestion, the samples were analysed by

cold vapour atomic absorption technique using Hilger-Watts Atomspek H 1550. Suitable standads were prepared from $HgCl_2$ Sediment organic carbon was estimated by the method of ElWakeel and Rile (1956).

Distribution of Cu, Zn, Mn, Fe and Hg in the sediments (dry) of the eleven stations (Fig. 1) studied and the values are given in Table I. The concentration of copper in the sediments ranged from 24 to 180 µg/g. The copper concentration was relatively higher at the stations 2931, 32 and 34 than those at the other stations. The concentration of Zn varied from 62 to 106 µg/g and was comparatively high at the stations 2961, 66 and 68. The level of manganese in the sediment was higher than those of copper and zinc, and the concentration varied from 196 to 806 µg/g. Of the eleven stations studied, stations 2961, 66, 67 and 68 recorded high levels (806, 486, 480 and 406 µg/g respectively) of manganese. The Fe concentration was found to be higher than the concentration of other trace elements in the sediments and the values were from 10.56 to 55.68 mg/g. Higher values of 44.8, 55.68, 38.58 and 38.0 mg/g were noted at stations 2961, 2966, 2967 and 2968 respectively. Mercury level in the sediments was very low. At most of the stations the levels were below the detection limit. The highest Hg concentration of 3 µg/g was noted at station 2932. The concentration of organic carbon varied from 3.93 mg/g to 5.45 mg/g.

The distributoin of Zn, Mn, Cu and Fe were not uniform in the sediment at the stations studied. This variation in the concentration may be due to differences in the sources of the heavy metals and complex reactions such as absorption, flocculation, etc., taking place in the sediments. High concentrations of Fe, Mn, and Zn in the sediments at stations 2961, 66 and 68 off Madras may be attributed to discharge of heavy metal containing industrial effluents, spillage of appreciable amounts of oil and ore dust into the harbour during loading and unloading operations and also the land drainage. The amount of Zn recorded in the present study was very low when compared with values reported elsewhere. LeeMeyerson, Luther, Krajewski and Hires (1981) reported Zn concentration as high as 2282 ppm at the mouth of Pilcreek-Arthurs Kill in Newark Bay. Kumaraguru (1980) also recorded a slightly high concentration of Zn (160 ppm) at the mouth of Vellar estuary in the Bay of Bengal during the monsoon period. According to Eisler, Lapan, Telek, Davey, Soper and Barry (1977) the Zn concentration of the sediments of Naragansett Bay was also high (206 mg/kg) which is higher than that observed in the present study in the Bay of Bengal sediments.

Cu and Hg concentrations were high at stations 2931, 2932 and 2934 which may be mainly due to industrial (metallurgical) and sewage discharge in these area. The main sources of the heavy metals in these area might be the industrial effluents of the industries which handle the metals like Madras Aluminium and steel Company, bleaching factories, many iron and steel companies, and Salem Ore handling project, which have sprung up in the Madras city and along the coast. Ore dust spilled during transport in harbour also contribute greatly to the metal concentration in samples collected close to Madras harbour. Sericano

and Pucci (1982) reported 24.1 ppm of copper in the industrial discharge area of Balanca Bay, in Argentina. This value is relatively low when compared to the amount of copper recorded in the present investigation. Eisler, Lapan, Telek, Davey, Soper and Barry (1977) also recorded a high concentration of copper (112 mg/kg) in the Narragansett Bay where anthropogonic wastes are discharged from New York Bight in Rhode Island. Copper values recorded in the present study are comparable to those reported from polluted Newyork Bight by Eisler, Lapan, Telek, Davers, Soper and Barry (1977). The amount of Hg recorded in the present study was low (0.1 to 3.0 µg/g) when compared to that of the sediments of Tyrrhenian sea where Balai, Bargagli and Renzoni (1979) recorded a Hg level as high as 11 µg/g. Zingde and Desai (1981) also noted 8.21 ppm of Hg in Thana creek near Bombay harbour. A high Hg level (31 ppm) was recorded in Newark Bay by Leemeyersen, Lnther, Krajewski and Hires (1981). The level of Hg (3 ppm) recorded by Donazzolo, Merlin, Vitturi, Orio, Pavoni, Perin and Rabitti (1981) in the sediments of Gulf of Venice, Italy, is quite comparable to that of the Bay of Bengal sediments studied during the present cruises. The presence of Hg in the sediments could be attributed to industrial dischage. Ganapati and Raman (1973) attributed high level of pollutants in the Visakhapatnam harbour to the discharges from Caltex Oil Refinery, the Coramendel Fertilizers, The Hindustan Polymers and the orehandling project. The other sources of pollution are from the oil and ore jetties located in the west and north arm of the harbour.

The organic carbon in sediment ranged from 3.93 to 5.45 mgC/g. Comparatively higher values were observed at stations 2931 and 2968 than at other stations studied along the coast of Visakhapatnam (Table I). The higher values

Table I. Concentrations of heavy metals and organic carbon in sediments in different stations (values given are per gram weight of dry sediment).

Stn. No.	Depth (m)	Fe mg/g	Cu µg/g	Mn µg/g	Zn µg/g	Hg µg/g	Organic carbon mgC/g
2931	89	10.56	164	244	82	2	4.96
2932	175	24.00	166	298	64	3	5.03
2934	345	26.48	180	196	72	2	4.96
2961	140	44.80	92	806	92	0.2	4.48
2966	230	55.68	94	486	86	ND	4.67
2967	158	38.88	78	480	82	ND	5.31
2968	195	38.00	78	496	106	ND	5.45
3004	200	30.04	26	236	74	ND	4.18
3005	200	36.08	24	422	62	0.1	3.93
3006	200	36.80	52	396	82	0.2	4.29
3007	200	37.00	30	232	62	ND	4.01

ND — Not detectable.

may be attributed to discharge of the wastes of leather industry, fertilizers and domestic wastes from Madras city and anthropogenic waste input through Adyar river. Thompson and Yeung (1982) also observed an increase in organic carbon in the Tolo harbour (Northeast Hong Kong) sediments due to sewage pollution.

From the mean concentrations of the various trace elements recorded, it would be evident that all the 7 stations viz. 2931, 32, 61, 66, 67 and 68 north of Madras showed relatively high values of Fe, Cu, Mn, Zn and Hg than the stations north of Visakhapatnam. Hg levels were undetectable in the sediments of stations 2966, 67 and 68 and also at stations 3004 and 3007 situated north of Visakhapatnam. The sediment organic carbon values were also higher in all 7 stations located north of Madras than in the stations situated north of Visakhapatnam (Table I). Relatively high concentrations of organic carbon and trace elements in the stations of Madras harbour and north of Madras may be attributed to the discharge of large amount of sewage and wastes from various chemical, metallurgical, textile, organo-mercurial paint industries and electrical apparatus industries along this coast and crude oil refineries in Manali (Madras).

ACKNOWLEDGEMENTS

The authors (A.R and B.L) thank Dr. V. V. R. Varadachari, Director, NIO for having given them an opportunity to participate in the 127th and 128th cruises of RV *Gaveshani*. They are thankful to Prof. Chandrasekar and Dr. Ravichandran (Annamalai University) and Dr. Alfred Selvakumar (NIO) for their help in the analysis of heavy metals by AAS. Thanks are also due to Chemical Oceanography unit of Andhra University and Mr. Dileepkumar of COD, NIO (Goa) for their help on board.

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