

Arsenic in Water, Plankton & Sediments Off Goa Coast & Adjacent Regions

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Arsenic content was estimated in water, plankton and sediments in the region between 14°40'N and 15°50'N surrounding Goa coast. Of the total arsenic content in water (1.65—4.78 $\mu\text{g/litre}$; av. 3.09 $\mu\text{g/litre}$) 61% was found as soluble inorganic arsenic and the rest as organic bound arsenic. Plankton and sediments also showed marked accumulation of this element, the average being 2.2 and 8.8 $\mu\text{g/g}$ respectively. Nearshore sediments showed higher values of arsenic indicating the influence of land drainage and industrial effluents.

This study formed a part of Institute's project on arsenic investigations in Arabian Sea and Bay of Bengal and was undertaken during 46 cruise of *R V Gaveshani* in Dec. 1978 between 14°40'N and 15°50'N off Goa coast and adjacent areas (Fig. 1).

Water samples were collected with Nansen bottles and preserved with 1 ml of 9N sulphuric acid/100 ml in PVC bottles. Samples were subsequently analysed for total arsenic and soluble inorganic arsenic using the method developed by Koroleff¹. The percentage standard deviation of the analyses was $\pm 23\%$. Organic bound arsenic was calculated by the difference.

Sediment samples were collected using a La Fond Dietz Snapper which sampled the upper 5 cm of the sediment. Zooplankton samples were collected with the help of a Neuston net (mesh size—500 μm). Sediment and zooplankton samples were dried at 80°C and total arsenic was determined spectrophotometrically by arsine-silver diethyl dithiocarbamate technique described earlier². The percentage standard deviation of the technique was observed to be $\pm 5\%$.

Water—Table 1 gives the arsenic concentrations of total, soluble inorganic and organic bound species in water at different depths. Onishi³ reported that total arsenic concentrations in Southwest Indian Ocean varied between 1.4 and 5 $\mu\text{g/litre}$ (av. 3 $\mu\text{g/litre}$) which is in good agreement with the present average of 3.09 $\mu\text{g/litre}$. The soluble inorganic arsenic content in this region also agrees well with that reported in general for the Northern Indian Ocean waters⁴.

In general, arsenic concentrations were relatively higher in the region off Goa as compared to the adjacent region in the north (off Vengurla). This is attributed to the effect of mining activities of iron ore. Shnyukov⁵ observed that iron ores are always enriched with arsenic owing to the high adsorptive capacity of the hydrous iron oxides. Higher values of organic

bound arsenic in the same region indicate significant contribution from the biogenic material.

Plankton—Zooplankton samples were examined for total arsenic content (Table 2). Kennedy⁶ reported the values from Newfoundland and Labrador ranging between 0.9 and 8.9 $\mu\text{g/g}$ wet weight whereas Bohn⁷ reported 6 $\mu\text{g/g}$ in West Greenland copepods while Leatherland *et al.*⁸ found 14.5 $\mu\text{g/g}$ in a copepod and 42 $\mu\text{g/g}$ in an euphausiid from the Northeast Atlantic Ocean. Present values of plankton are far on the lower side as compared to the above ranges. The variations observed are attributed to the difference in species composition of the plankton. Zooplankton derives this element through phytoplankton which is known to extract this element as a nutrient having a biological function in sea water as a phosphate analogue⁹. Zooplankton forms an important link in the food chain mediating the incorporation of this element to the animals of higher trophic levels. Onishi³ reported the general concentration levels of arsenic in marine animals (mostly fishes and other higher organisms) as between 0.1 and 50 $\mu\text{g/g}$. Zooplankton may also be directly responsible in contributing this element to the sediments by sinking after their death.

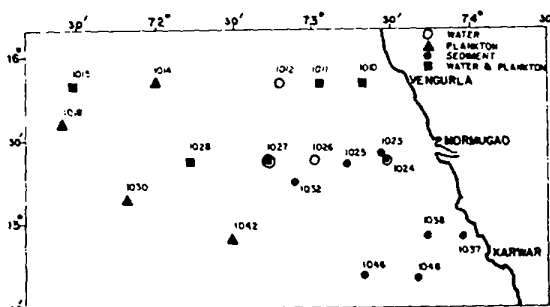


Fig. 1—Station locations

Table 1—Arsenic Concentrations in Water

St No	Depth m	Arsenic conc. $\mu\text{g/l}$		
		Total	Soluble inorg.	Organic bound
1010	0	3.85	2.31	1.54
	25	1.86	1.15	0.71
	50	1.92	1.17	0.75
1011	0	3.08	1.88	1.20
	25	2.69	1.61	1.08
	50	2.69	1.69	1.00
1012	75	1.65	0.99	0.66
	0	3.08	1.88	1.20
	25	2.32	1.39	0.93
1045	50	3.41	2.18	1.23
	100	2.60	1.59	1.01
	275	3.74	2.28	1.46
1045	0	1.82	1.09	0.73
	50	3.55	2.20	1.35
	100	3.03	1.85	1.18
	500	2.72	1.63	1.09
	1000	1.92	1.17	0.75
	1500	2.36	1.42	0.94
1015	2000	2.98	1.85	1.13
	0	3.47	2.15	1.32
	25	3.85	2.31	1.54
1026	50	3.71	2.34	1.37
	0	3.85	2.31	1.54
	25	4.78	2.87	1.91
1027	50	2.35	1.43	0.92
	75	4.18	2.59	1.59
	100	4.29	2.57	1.72
1028	0	2.02	1.21	0.81
	25	2.39	1.46	0.93
	50	3.60	2.16	1.44
1028	25	4.62	2.86	1.76
	50	2.77	1.69	1.08
	75	1.92	1.15	0.77
	200	4.26	2.64	1.62
	1000	3.49	2.56	0.93
1500	4.63	2.87	1.76	

Sediments—The arsenic values in the sediments (Table 3) are comparable to those reported^{2, 6, 10, 11}.

Concentrations of arsenic observed in the sediments off Goa (av. 10 $\mu\text{g/g}$) were higher than those of off Karwar sediments (av. 7.3 $\mu\text{g/g}$). The higher values in Goa region could be attributed to the mining activities of iron ore as stated earlier. Texture of the sediments was also found to play an important role in retaining the element. Arsenic was more in the sediments having higher percentages of silt and clay. The nearshore sediment samples of both Goa and Karwar regions (sts

Table 2—Total Arsenic in Zooplankton

St No	As dry wt $\mu\text{g/g}$	St No	As dry wt $\mu\text{g/g}$
1010	1.4	1016	0.8
1011	1.5	1028	2.4
1014	5	1030	2.2
1015	2.2	1042	1.8

Table 3—Total Arsenic in Sediments

St No	Depth m	Texture*	As dry wt $\mu\text{g/g}$
1023	20	Sandy silt	13.1
1024	56	Sand	8.6
1025	82	-do-	5.8
1027	300	Sand-silt-clay	12.6
1032	240	—	10.3
1037	20	Sandy clay	13.6
1038	52	Sand	5.
1046	107	-do-	5.1
1048	54	-do-	5.7

* Ansari Z.A. (personal communication)

1024, 1037) showed higher values than those of respective offshore samples. This would indicate that the effects of land drainage and industrial effluents are felt more in the nearshore sediments than those of offshore.

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