Elemental Concentrations in Bombay Harbour Sediments

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Grab samples of sediments collected from 19 stations in the Bombay Harbour Bay between Dharamtar creek and Thana creek during 1968 were analysed for the distribution of leachable elements. Concentration factors for Ca, Sr, Fe, Cu, Zn, Mn and P in Bombay sediments were found higher than those of Tarapur sediments examined by others. These data were utilized for arriving at the maximum permissible concentration levels for some radionuclides in sediments. The data may be useful in predicting the role of sediments in scavenging the radioactive wastes.

Bombay Harbour Bay regarded as a shallow estuary is the region of great importance as it is most exploited by local fishermen. The estuary is the region of great importance was given HF and HCl04 treatment and mixed with the above extract. The final solution was made to 500 ml in 1N HCl. Aliquots of the solutions were taken for the determinations of various elements.

Calcium and magnesium8,9 were determined by titration with EDTA and magnesium solution. Potassium8 was precipitated by sodium cobaltinitrite reagent and the precipitate after being washed with wash solution was dissolved in conc. HCl (5 ml) and K was estimated in a known excess of ceric sulphate according to Vogel. Strontium10 was precipitated as oxalate and determined by atomic absorption spectrophotometry (AAS) using the method of addition. Zincc11 was estimated in the leachate by AAS. Copper and iron12 were estimated spectrophotometrically through their diethyldithiocarbamate and 1-10, O-phenanthroline complexes respectively. Manganese12 was oxidized with potassium periodate to permanganic acid and determined colorimetrically. Cobalt12 was determined spectrophotometrically by the nitroso-R salt method. For the estimation of phosphorus9 the solution was passed through an anion exchange resin (Dowex-1, 50-100 mesh) in 10N HCl for removal of iron and the phosphate in the effluent was estimated through the molybdenum blue reactions.

Results and Discussion

Location of the sampling stations is given in Fig. 1. Data on the distribution of major and minor elements are given in Tables 1 and 2, respectively. Table 3 gives the comparative values of the concentration factors for the sediments off Tarapur and Bombay Harbour.

Ca content in the samples ranged from 17 to 46 mg/g. These values are slightly higher than those reported by Sarma et al.14 in Tarapur sediments.

Sr in the samples varied between 175 and 375 μg/g. Sarma et al.14 reported comparatively lower values for Sr in the Tarapur sediment samples (range 89-110 μg/g). Sr to Ca atom ratio varied from 2·46-6·86 × 10⁻³, and distinctly lower than the Sr/Ca...
atom ratio of $8.9 \times 10^{-3}$ in sea water reported by Viswanathan et al.\textsuperscript{10}. This shows that the sediments discriminate against Sr in preference to Ca.

Young\textsuperscript{15} has reported average value of 296 ppm of Sr (av. of 29 samples) in the nearshore sediments off Washington DC. The average Sr content in Bombay Harbour samples is 252 ppm.

**Table 1 — Elemental Concentration in Sediments (N/20 HCl Leach)**

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Potassium</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Iron</th>
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<tr>
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</table>

Concentration of Mg in the samples ranged from 4.5 to 16.5 mg/g. In the Tarapur region the range was 6.5-3 mg/g, while in Angria bank sediment samples\textsuperscript{14} the Mg content ranged between 6 and 25 mg/g.

Duursma and Eisma\textsuperscript{17} and Duursma\textsuperscript{18} analysed 2 sediment samples from Bombay Harbour for mineral composition, grain size and chemical composition. According to them the mineralogical composition showed illite as the dominant fraction in the sample analysed\textsuperscript{19}. The harbour samples collected from the same area were analysed in this laboratory for the major and trace elements. High K values of 3-6·5 mg/g confirmed higher percentage of illite in the samples. The values reported by them for Ca, Fe, Co, Zn and Sr agreed well with the present analyses.

HCl (N/20) leach values for different elements in the present studies were compared with values reported by Ganapathy et al.\textsuperscript{20} for Bombay Harbour. Average values for Ca, Mg, Sr and Mn agreed well with their values while average values for K, Fe, Cu and Zn were higher in the present work.

From the concentration of elements in Bombay Bay waters\textsuperscript{8} and labile component of the elements obtained in the sediments (Tables 1 and 2) the concentration factors (CF) were calculated.

$$\text{CF} = \frac{\text{Conc. of element (labile) in sediment (ug/g)}}{\text{Conc. of element in sea water (ug/ml)}}$$

When CFs for different elements were compared with those of Tarapur (premonsoon) it was noticed...
in general that Bombay sediments (premonsoon) showed higher CIs than those of Tarapur except for K, Mg and Co.

Organic material produced by the detritus resulting from various sources such as the disintegration of marine organisms, influx of terrestrial materials, etc., concentrate at the bottom. Larger amounts of radionuclides are likely to be ingested from sea food diet comparatively richer in bottom dwelling organisms for benthic invertebrates utilise bottom organic detritus as the source of nourishment and these benthos are utilized as food for human consumption.

Larger benthic forms ingest the detritus mixed with sediments and in this process the labile form of the elements from sediments are leached by their stomach fluid which is somewhat acidic.

In the present work N/20 HCl is used as it removes the labile part of the elements present in the sediments including the amount present as hydrous oxide. Even though the water concentration may be below maximum permissible level, some bottom living organisms may accumulate considerable amount of radioactivity through their food.

From the trace element data available for sediments and maximum permissible concentrations (MPC) of the radionuclides in sea water, MPC in sediments have been computed. The model calculation arriving at various values is as follows (taking specific example of $^{90}\text{Sr}$):

MPC of $^{90}\text{Sr}$ in sea water $= 3-3 \times 10^{-7} \mu\text{Ci/mL}$ of sea water

Sr content of sea water $= 8 \mu\text{g/mL}$ (av. of 26 samples from the same area)

Sr content of sediment $= 252 \mu\text{g/g}$ (av. of 19 analyses)

If 8 $\mu\text{g}$ of Sr present in 1 mL of sea water is assumed to contain 1 MPC of $^{90}\text{Sr}$ and if 1 MPC of $^{90}\text{Sr}$ is assumed to be uniformly distributed with Sr present in 1 g of sediment, then 252 $\mu\text{g}$ of Sr in sediment will have

$$\frac{252 \times 3-3 \times 10^{-7}}{8} \mu\text{Ci of } ^{90}\text{Sr}$$

In other words, 1 $\mu\text{g}$ of Sr in sediment will have

$$\frac{252 \times 3-3 \times 10^{-7}}{252 \times 8} = 4-12 \times 10^{-8} \mu\text{Ci of } ^{90}\text{Sr}$$

Table 4 gives MPC levels for various radionuclides of interest.

If the concentration of radionuclides in sediment is main’aimed below the level mentioned in Table 4, then there is no possibility of transfer of activity above the permissible limit from marine sources feeding on bottom sediments.

MPC values of some elements in sediments calculated in this work may need revision in light of new data and information that may be collected in future. However, large differences from these data are not expected.

Thus far no systematic study of geochemical aspects of Bombay Harbour has been undertaken. It is the leachable part out of the total chemical inventory of the sediment that take part in chemical and biological interactions. These elements in available forms present in sediments only take part in exchange reaction with radionuclides.

The degree to which a given radionuclide is taken up and retained by an organism depends to a large extent on the amount of the stable isotope of the same element present in the environment. Comparison of these stable element data for Bombay Harbour and Tarapur region helps to understand the fate of radionuclides released in the coastal environment. The data presented in this paper will be useful source of information in various fields like pollution, disposal of radioactivity, geology, oceanography, etc.

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References


