

## Fluoride, Bromide & Iodide in the Arabian Sea

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Fluoride concentrations varying from 1.32 mg/l at the surface to 1.37 mg/l at depth showed an average of  $1.35 \pm 0.004$  mg/l with F/Cl of  $(6.65 \pm 0.07) \times 10^{-5}$ . Average bromide was 70 mg/l with Br/Cl of 0.00347. Bromide was found to bear a fairly constant ratio to chlorinity. Concentrations of iodide were small (0.01-0.024 mg/l) with higher concentrations occurring at the surface and bottom layers. Results suggested the semi-conservative, conservative and non-conservative characters of fluoride, bromide and iodide respectively.

Some investigations on fluoride and bromide have been carried out in the Arabian Sea, Andaman Sea and the Bay of Bengal<sup>1-4</sup>. In the present paper, results of estimations of halides (except chloride) in samples collected during the 89th cruise of *R V Gaveshani* from the Arabian Sea are reported.

Salinities were determined on board using an AUTOSAL salinometer with a sensitivity of 0.003‰. Fluoride was analysed employing the colorimetric lanthanum-alizarin complexone method of Greenhalgh and Riley<sup>5</sup>. Spectrophotometric method of Saenger<sup>6</sup> was used for the estimation of bromide. Iodate was estimated by the method of Johannesson<sup>7</sup> with the modification of Truesdale and Spencer<sup>8</sup>. Total iodine was estimated in the sample after oxidising iodide to iodate. Iodide was determined by difference.

To analyse the data, the area of study was divided into 2 regions: nearshore-having a total of 11 shallow stations and offshore-containing 3 deep stations (Fig. 1).

One of the salient features of the observations was the occurrence of considerably low fluoride values at 16°31'N, 72°08'E. The fluoride levels ranged from 1.2 mg/l at the surface to 1.26 mg/l in the bottom waters. A close look at Fig. 1 revealed that this station was located on the Angna Bank and had a depth of 17 m. Since it had a rocky or coralline bottom the loss of fluoride can most probably be attributed to the formation of apatite. The deeper layers nearer the coast showed a distinct depletion in the concentration compared to stations away from the coast. Removal of fluoride by natural agencies and its incorporation in the sediments are likely. The offshore waters showed the same patterns of distribution at different depths, but at 400 m an increase in fluoride was seen which was probably due to the effect of Persian Gulf water. The second notable maximum occurred at 1000 m (1.39 mg/l). This may be due to the intrusion of Red Sea water masses. It has been observed that fluoride can be

removed in the absence of low oxygen and can be redissolved when oxygen concentrations increase<sup>9</sup>. It was found, that in the zone of low oxygen concentrations, fluoride maintained almost constant values. These variations in fluoride caused by different factors either individually or collectively suggest the semi-conservative character of fluoride. It was of interest to note that the difference between average

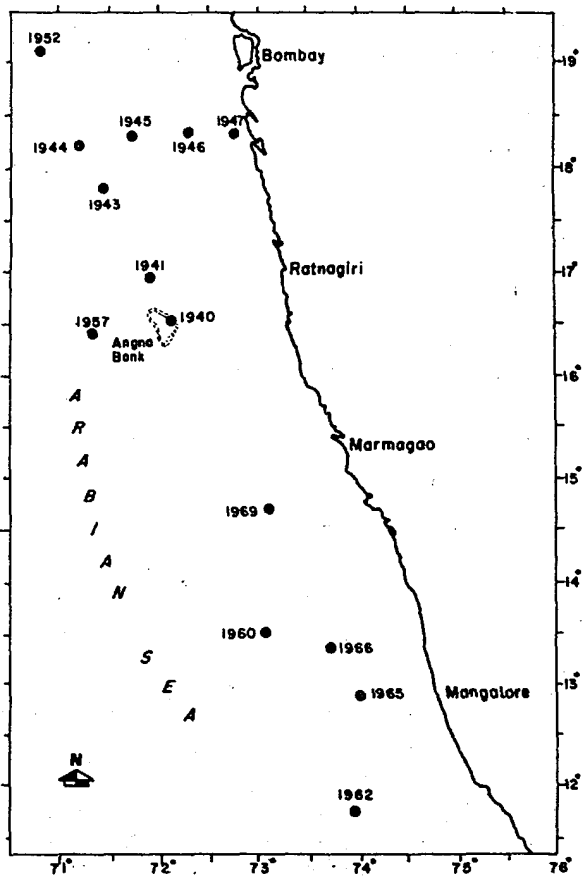


Fig. 1—Position of stations

fluoride concentrations in the nearshore and offshore waters was quite insignificant. The average fluoride concentration was  $1.35 \pm 0.004$  mg/l with F/Cl of  $6.65 \pm 0.07 \times 10^{-5}$ .

As the general trend of variation of bromide (av. 70 mg/l) and chlorinity was similar at all stations, the results were pooled to present a general picture of the area. Below 25 m, concentrations of bromide increased with the increase of oxygen till it reached 100 m depth, below which it decreased with decreasing oxygen. This was attributed to water mass effect as the salinity followed the same trend indicating the conservative character of bromide. The maximum bromide concentration at 800 m, which was also reflected in higher chlorinity was probably due to high bromide levels associated with the Red Sea. As the bromide/chlorinity ratio (0.00347) was fairly constant, irrespective of depth and location, it indicated the conservative character of bromide in the Arabian Sea. In the Baltic Sea, the ratio decreased with chlorinity, as the fresh water added had a relatively low ratio<sup>10</sup>.

No particular trend of depthwise variation could be noted for the species of iodine (av. 0.015 mg/l with I/Cl of  $0.78 \times 10^{-6}$ ). However, the concentrations of iodide were greater in the upper and bottom layers. It was also observed that iodide which is a metastable form of iodine, seemed to form a minor part of iodine. Present range of iodide (0.01-0.024 mg/l, av. 0.015 mg/l) compared well with the range <0.01 to 0.2  $\mu$ M for iodide as recorded by Tsunogai and Henmi<sup>11</sup>. Iodide

may be produced in deep water from the decomposition of organic matter and from iodate reduction from unevenly distributed sources in or near the bottom<sup>12</sup>. The iodide in the surface could be attributed to reduction of iodate by biological activity<sup>13</sup>.

Thus, the irregular distribution of iodide in the Arabian Sea unlike that of other halides which were conservative and semi-conservative elements indicated the non-conservative character of iodide.

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