

Studies on Boron along the Central West Coast of India

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Boron in its inorganic form in the Arabian Sea waters varies from 1.17 to 4.74 mg/kg. There is, at some stations, depthwise correlation between inorganic B and primary productivity. B/Cl varies from 0.122 to 0.238 for shallow stations and from 0.06 to 0.241 for deep stations with a mean B/Cl of 0.173 for the area surveyed. In the euphotic zone, B is utilized by phytoplankton during high productivity. Less defined correlation exists between inorganic B and the oxygen distribution in a vertical profile. Oxygen concentration at its minimum shows a corresponding release of B during oxidation of organic matter.

Boron occurs widely throughout the earth's crust. Its concentration ranges from 0.013 ppm in fresh water to 120 ppm in marine plants¹ with an average of 4.5 mg/kg (ref. 2) at salinity of 35‰. Concentration of B in oceans does not change appreciably and bears comparatively a constant ratio with other conservative constituents of seawater. Buch³ has reported a mean value of 4.67 mg B/kg at a salinity of 35‰ with the corresponding B/Cl of 0.241. Also it is shown² that the B/Cl in seawater is constant within the limits of experimental error. Results achieved by several workers in different marine environments vary from 0.209 for the Gulf of Mexico to 0.264 for the Baltic seawater⁴.

Most of the work done on B in the Indian Ocean is confined to the Bay of Bengal region^{5,6}. The present work deals with the study of boron and its relationship with other constituents of seawater in the central west coast of India (Arabian Sea).

Samples were collected during the 89 cruise of *R V Gaveshani* from standard hydrographic casts at stations shown in Fig. 1, using PVC Niskin samplers and stored under low temperature in a well cleaned sealed polyethylene bottles. At each station samples were so collected as to cover the entire water column and analyses for inorganic B were carried out several weeks later in the shore laboratory. It has been confirmed that the storage under refrigeration gave unaltered results even after 6 months⁷.

Samples were also analysed for salinity, dissolved oxygen, pH and temperature. Standard methods were adopted for the analyses of these parameters⁸.

Inorganic B was estimated spectrophotometrically, using the non-aqueous solvent method of Hulthe *et al.*⁹ with slight modifications. Propionic anhydride and oxalyl chloride were replaced by acetic-anhydride and hydrochloric acid and acetone with methyl isobutyl ketone (MIBK).

A total of 120 samples from 17 stations were analysed for inorganic B. The precision of the analyses with the instruments and reagents available was

determined from repeat analyses of several samples. Standard deviation for the method was $\pm 1.18\%$ and standard error 0.0021.

B varies in the present study from 1.17 to 4.75 mg/kg with a mean concentration of 3.33 mg/kg. Ratios of B to Cl (Cl ‰) are between 0.0904 and 0.241 with a mean value of 0.173. B content shows a high correlation with Cl concentrations at various depths for shallow as well as for deep stations (Fig. 2). In case of deep stations, high average variation of B/Cl is observed at oxygen minima. This may be due to the soluble organic borate complexes degraded in this zone which liberate detectable B¹⁰. Primary productivity calculated varies from 0.7 mg C/m³/day at 90 m depth to 54.9 mg C/m³/day at the surface¹¹.

Depth profiles of dissolved oxygen, B, Cl ‰ and the primary productivity are shown in Fig. 2 separately for

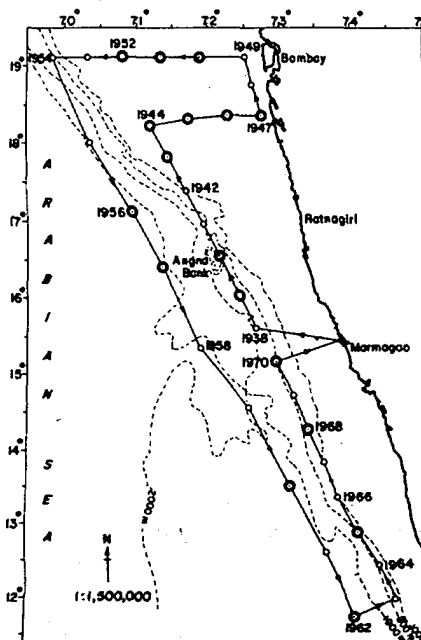


Fig. 1—Position of stations

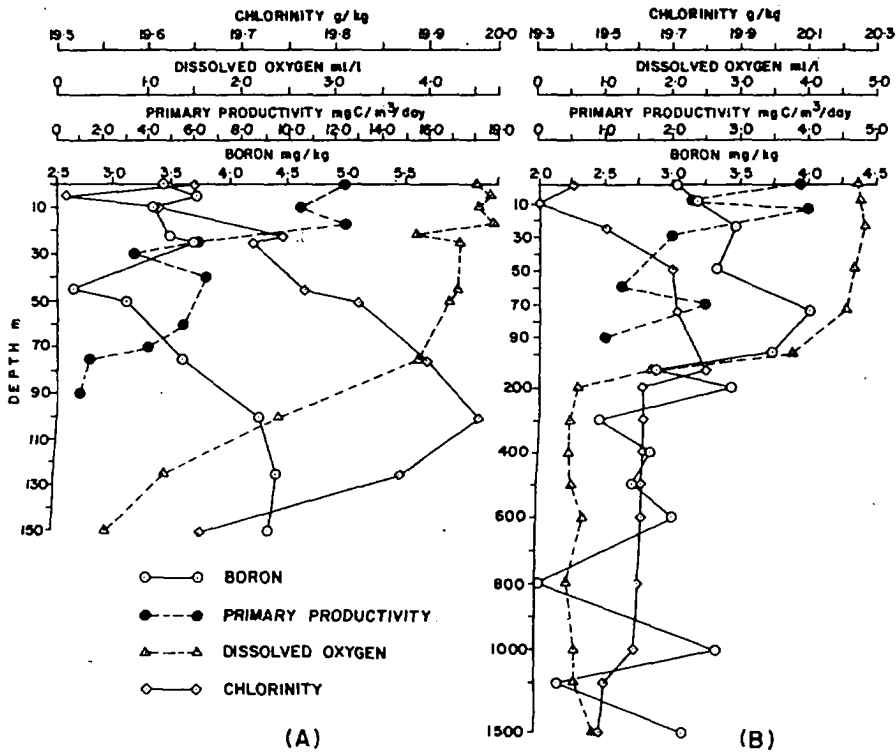


Fig. 2—Average vertical variation of different parameters at shallow (A) and deep (B) stations

shallow as well as for deep stations. In general, lower values of B in the upper layers of shallow stations show that B is utilized by phytoplankton^{1,2} and also it may be due to evaporation loss¹³. Mean values of B at the surface for shallow as well as deep stations are 3.47 and 3.044 mg/kg respectively, likewise the mean productivity is 12.422 and 3.9 mg C/m³/day and the oxygen is 4.5 and 4.72 ml/l. B has lower concentration at the surface, increasing slightly below and again decreasing further down. It starts increasing from 70 m onwards. Productivity and dissolved oxygen contents obey the antipathetic relationship towards this variation of B.

In Fig. 2A, at a depth of 45 m, there is a marked depletion in the concentration of B with a concomitant increase in the dissolved oxygen content. Primary productivity values in the region vary from 6.5 mg C/m³/day at 40 m and 5.48 mg C/m³/day at 60 m. Similarly in Fig. 2B, productivity values from 15 to 70 m depth vary from 4 to 2.5 mg C/m³/day. B values are correspondingly lower and increase at depths above 80 m where the concentration of oxygen is low. This shows that the decrease in the concentration of B in the euphotic zone is due to the utilization of B by phytoplankton during high productivity and this utilized B is released into the water at depth where the concentration of oxygen is low. Some B may be removed in particulate form as well.

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