the transport of freshwater equatorward from the head BB by the wind-driven East India Coastal Current during the winter monsoon[9].

In conclusion, analysis of temperature and salinity profiles collected during the post-tsunami period provided a wealth of information, which suggested that the thermohaline structure in the eastern BB was modulated by a drift of low saline water from the AN Sea. The influx of freshwater from the northern BB reduced surface salinity by 0.8 psu and stratification was observed in the vicinity of the Chennai coast. West of the AN Islands, SST increased by 0.8°C and significant temperature variations above 250 m were observed. An upward shift of the 20°C isotherm was observed at all locations, suggesting vertical entrainment. Modulations in the hydrographic properties were expected to have a strong impact on the flora and fauna in the vicinity of the AN Islands.

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Sea-water pH and planktic foraminiferal abundance: Preliminary observations from the western Indian Ocean

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The planktic foraminiferal abundance has been calculated in a set of 28 surface sediment samples collected from the equatorial and southwestern Indian Ocean. In order to understand the influence of changing sea-water pH on the planktic foraminiferal abundance, the latter has been compared with average sea-water pH of the top 500 m of the water column, measured *in situ*. Though water depth shows a marked influence on the planktic foraminiferal abundance, pH also appears to affect the overall abundance of planktic foraminifera. The preliminary results indicate that the planktic foraminiferal abundance is directly proportional to sea-water pH.

Keywords: Abundance, pH, planktic foraminifera, sea-water, water depth.

VARIOUS physico-chemical and biological parameters control the foraminiferal abundance. Besides temperature and salinity, isotopic composition of the foraminiferal shells has also been shown to vary under changing carbonate ion concentration of the sea water as well as pH[1]. The close relationship between sea-water pH and ocean carbon reservoir, lead to the development of foraminiferal proxies, to infer sea-water pH during geologic past. The boron isotopic composition of the selected foraminiferal species has been developed as an efficient proxy to infer past sea-water pH[2,3]. Based on the laboratory and field-based studies, significant influence of sea-water pH on the boron isotopic composition of the foraminiferal shells has already been established[4]. Additionally, the shells of few foraminiferal species have been shown to dissolve under reduced pH conditions in laboratory culture studies[5]. The dissolution of foraminiferal tests as a result of change in pH with changing salinity has been proposed to affect the abundance of foraminiferal species as well[5,6].

Nevertheless, studies dealing with the effect of changing sea-water pH on the dissolution of the foraminiferal shells are limited. Therefore, in the present study we explore the possible influence of changing sea-water pH on the foraminiferal abundance in a set of samples collected along a

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north-south trending transect in the western Indian Ocean.

A total of 28 samples (including grab and core tops of piston and gravity cores) collected along a north–south transect from the western Indian Ocean (Figure 1) were used for the study. Table 1 provides the details of each sampling station. All the sediment samples were processed according to standard procedures. An appropriate amount of sediment from each sample was dried overnight at 45°C. Dried sediment samples were soaked in water and subsequently treated with sodium hexa-metaphosphate in order to dissociate clay lumps. The treated sediments were sieved using a 63 μm sieve. Plus 63 μm fraction was dried and transferred to plastic vials. While processing the sediment samples, utmost care was taken to avoid any possible breakage of the foraminiferal tests, using extremely low water pressure during sieving. The sand fraction (>63 μm) was dry-sieved using a 125 μm sieve. From the >125 μm fraction an aliquot was taken by quartering and coning, to pick a minimum of 300 specimens of planktic foraminifera. The abundance of planktic foraminifera per gram sand was calculated and compared with the sea-water pH averaged for the top 500 m of the water column.

The pH was measured *in situ* at different depths (0, 10, 25, 50, 100, 200, 500, 750, 1000, 1500, 2000, 3000 m/max) with the help of Niskin water samplers attached to the CTD probe. Sea-water pH was determined immediately after the collection of sea water using a Digital pH meter (ELICO model: LI 127) provided with automatic temperature compensation (ATC) probe. The pH meter was calibrated with multi-point known pH standards. The values determined were repeatable with the error of 0.01 pH unit scale.

The pH averaged (average of pH values recorded at various water depths up to 500 m) for the top 500 m of the water column was used for the present study, because of the occurrence of live planktic foraminifera up to this depth, during different stages of their life cycle[7].

Since depth of the water column affects the foraminiferal abundance and the assemblage finally accumulating at the sea bottom[8], water depth at each location was plotted in order to assess its influence on foraminiferal abundance.

Distribution of planktic foraminiferal abundance in the study area indicates that the lowest value (204/g sand) was reported at the sample collected from the deepest water depth (4518 m), while the highest (105,476/g sand) was reported at station number SK 200/15, collected from a water depth of 2984 m (Figure 2). Within 2000–4000 m water depth, planktic foraminiferal abundance shows an apparent inverse relationship with water depth, viz. abundance increases with decreasing water depth. The pH ranged from 7.9 to 9.1 (Figure 2). At this point we are not able to understand the cause of anomalously high pH value at a few locations in the present study area, compared to the reported range of sea-water pH from different parts of the world's oceans. However, the objective of

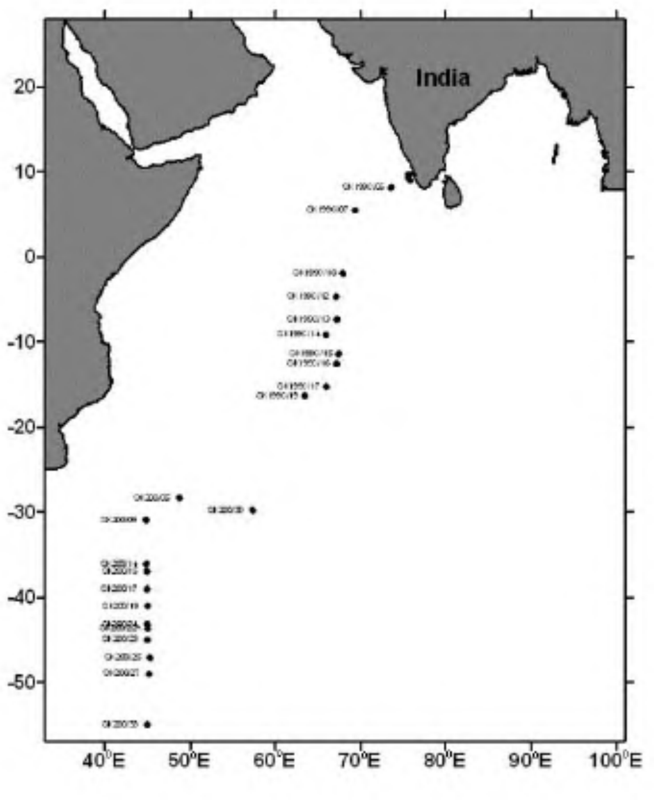

Figure 1. Location of sediment samples.

Table 1. Details of sampling stations along north–south transect in the Indian sector of the Southern Ocean

Sample no.	Latitude	Longitude (°E)	Water depth (m)
SK199C/01	9.69	75.75	87.0
SK199C/02	9.64	75.60	319.0
SK199C/03	9.50	75.51	1030.0
SK199C/04	9.41	75.39	1516.0
SK199C/05	8.99	75.82	2738.0
SK199C/06	8.13	73.56	2250.0
SK199C/07	5.51	69.35	3944.0
SK199C/10	–1.92	67.88	2597.0
SK199C/12	–4.69	67.10	3320.0
SK199C/13	–7.36	67.17	3305.0
SK199C/14	–9.18	65.96	3373.0
SK199C/15	–11.42	67.40	3513.0
SK199C/16	–12.59	67.14	3722.0
SK199C/17	–15.28	66.01	3368.0
SK199C/19	–16.27	63.46	4003.0
SK200/05	–28.32	48.73	2295.0
SK200/09	–30.91	44.86	2227.0
SK200/14	–36.12	44.89	2805.0
SK200/15	–37.00	44.98	2984.0
SK200/17	–39.03	44.97	4022.0
SK200/19	–40.98	45.06	2532.0
SK200/21	–43.15	44.98	3210.0
SK200/22A	–43.69	45.07	2723.0
SK200/23	–45.00	45.01	1423.0
SK200/25	–47.10	45.33	3285.0
SK200/27	–49.01	45.22	4377.0
SK200/33	–55.01	45.01	4185.0
SK200/39	–29.80	57.35	4518.0

the present study is to understand the possible influence of relative changes in sea-water pH on the planktic foraminiferal abundance in the southwestern Indian Ocean. Comparatively increased pH has been reported between 35°S and 43°S latitudes. Though pH values are available for only the lower half of the transect, there appears to be a direct relationship between the planktic foraminiferal abundance and pH, with more number of planktic foraminiferal tests recovered at the stations with comparatively more alkaline pH.

It is an established fact that post-death transport of planktic foraminiferal tests from the surface of the water column to the sea bottom results in considerable dissolution of the calcitic tests[9]. The dissolution of foraminiferal tests during the transport to the bottom depends on various factors[10], among which depth of the water column is one of the most important factors affecting planktic foraminiferal abundance[8]. The inverse relationship between water depth and planktic foraminiferal abundance in the present set of samples, probably reflects the increased dissolution of the tests during the bottomward sinking of the tests after death. Numerous field and laboratory studies have shown dissolution of a large number of tests during sinking and at the seafloor under the influence of under-saturated waters[9,11–13]. However, post-depositional taphonomic processes operating at the sea bottom and the top several centimetres of the sediments, and mainly controlled by the water mass occupying the studied depth, may also affect the foraminiferal tests. Nevertheless, influence of any such process is ruled out in the study area,

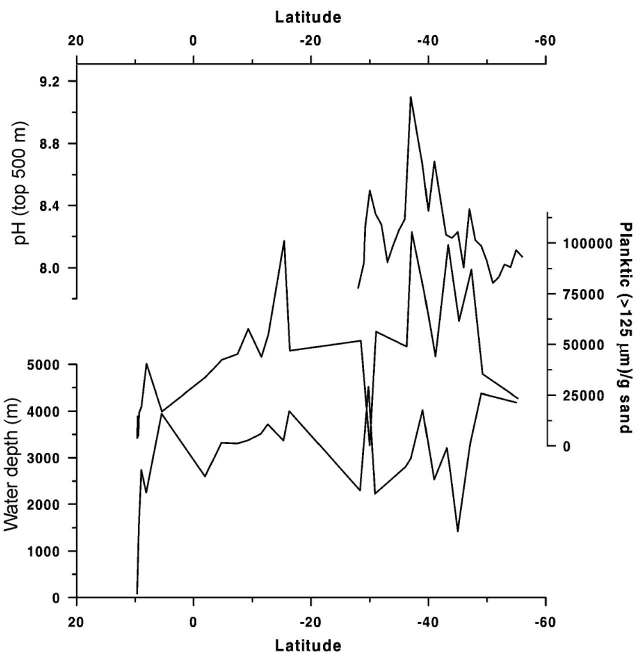

Figure 2. Plot showing abundance of planktic foraminifera with respect to water depth and pH at different latitudes. pH values were available only for the part of the transect.

as majority of the samples have been recovered from the water depth occupied by the same Indian deep water (occurs from ~3800 to ~1500 m depth)[14].

The pH of sea water mainly indicates marine carbonate chemistry, which in turn can be used to infer changing atmospheric pCO_2. Information of changing atmospheric pCO_2 over geologic past is helpful to understand the role of greenhouse gases in regulating the global temperature[15]. The apparent direct relationship between planktic foraminiferal abundance and sea-water pH indicates that the sea water with comparatively higher alkaline pH is more suitable for the growth of planktic foraminifera. Though the change in pH might affect different species to varying extent, in general the collective response of planktic foraminiferal population (dominated by *Globigerina bulloides*, *Globigerinoides ruber*, *G. sacculifer*, *G. conglobatus*, *Orbulina universa*, *Neogloboquadrina pachyderma*, *Globorotalia menardii*, etc.) appears to show a positive response to the increasing sea-water alkaline pH. The decreasing sea-water pH combined with decreasing temperature towards higher latitudes will lead to increased solubility of carbon dioxide and thus undersaturation of sea water. The undersaturated sea water in turn affects the planktic foraminiferal population leading to decreased abundance of planktic foraminifera in this region. Though boron isotopic composition of foraminifera has been used earlier to infer past sea-water pH, this study indicates the potential application of changing planktic foraminiferal abundance to infer changes in sea-water pH. It is important in view of the limitations of the boron isotopic composition to infer past sea-water pH[16].

However, for such studies the effect of the remaining factors influencing planktic foraminiferal abundance significantly, mainly productivity and bottom-water processes, has to be ascertained before hand. Interestingly, the technique can be used more effectively in regions with limited seasonal changes in surface water productivity like the southwestern Indian Ocean.

Based on the present study, it may be concluded that the planktic foraminiferal abundance in general increases as the sea water becomes more alkaline. Though the depth of sea water has significant influence on planktic foraminiferal abundance, with increasing abundance reported at decreasing water depth (within specific water depth region), sea-water pH also appears to influence planktic foraminiferal abundance. However, many such transects from different marine regimes of the world's oceans need to be considered for similar investigations to further augment the present conclusion.

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Organic carbon stock map for soils of southern India: A multifactorial approach

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Data acquired during soil resource inventory of central Western Ghats, India, were supplemented with other available environmental data to estimate/map soil organic carbon (SOC) stock at the regional level. For an area (about 88,000 sq. km) stretching between Goa and the Palghat Gap, a model was developed linking SOC stock to the different environmental parameters known to control SOC levels, particularly type of land cover. Forests of different status, presenting varying stages of degradation, still occupy 43,000 sq. km in this area. This can explain the higher SOC stock (0.44 Pg) estimated compared to figures published earlier.

Keywords: Biodiversity hotspot, data mining, land cover, soil organic carbon.

CONSIDERABLE efforts have been made in India over the last twenty years to provide the country with a modern and homogeneous soil map[1–5], for which acquisition of voluminous data was required. In the meantime, the role of the soil carbon pool in the global carbon cycle has attracted a lot of attention, especially since the Rio Summit in 1992. It has long been established[6–8] that temperature, rainfall, soil texture, pH and type of vegetation or land cover are the major factors controlling the level of soil organic carbon (SOC). Despite this, most of the estimations of SOC pool at the global level[9,10], or at European[11] or Indian[12] scales are based only on the soil type (soil taxa based approach)[13], i.e. the SOC content or stock is calculated and averaged for a soil unit or a group of units and these values are used to compute global statistics or to prepare maps. There is therefore disagreement between the objectives of such studies, which aim at providing landscape managers with tools for enhancing C sequestration in soils; their actual usefulness is limited by the fact that land-cover changes can hardly be taken into consideration to estimate soil carbon pool evolution.

Land-use changes cannot be ignored where carbon management is concerned and, in their pioneering study

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