Abstract

The present work focuses on the biogeochemistry of nitrogen and its isotopes in the Northern Indian Ocean (the northeastern Arabian Sea and the Bay of Bengal). Availability of nitrogen in the euphotic zone is an important modulator of the oceanic primary productivity and export production and, therefore, of carbon dynamics. Interrelated physical processes and biogeochemical transformation processes contribute to nitrogen availability and the fertility of the upper ocean. Our knowledge remains rudimentary in the northeastern Arabian Sea and in particular, the Bay of Bengal, with respect to the quantitative relationships and feedbacks between C and N cycles. The present work aims to understand the biogeochemical aspect of nitrogen and its isotopes in the northeastern Arabian Sea and the Bay of Bengal by

(i) Estimating the natural isotopic variability of nitrogen in surface suspended matter.

(ii) Estimating the new and regenerated productions.

The northeastern Arabian Sea was studied during the Indian JGOFS but new production measurements were not made. *This is a first attempt to quantify the new and regenerated productions in both the basins**. The Bay of Bengal has been studied during pre (April-May 2003) and post (September-October 2002) monsoon seasons, whereas the northeastern Arabian Sea has been studied during the middle and waning phases of winter monsoon (January and Late February-Early March).

The results from the Bay of Bengal reveal consistent high new production during both seasons; however, the productivity is higher during premonsoon than postmonsoon. New production during April-May 2003 (overall average~ 5.45 with shelf region average of 6.94 and offshore average of 3.58 mmolN $m^{-2}d^{-1}$) and September-October 2002 (overall average~ 2.61 with shelf stations averaging around 2.26 and offshore region around 3.06 mmolN m^{-2} d^{-1}) in the Bay of Bengal are indeed comparable to the high new production off India, 5.2±2.3 mmolN m^{-2} d^{-1} reported for the Arabian Sea. This observed high new production in the moderately productive Bay of Bengal could be one of the reasons for the observed high organic carbon fluxes in the sediment traps at depth; these fluxes in the Bay are comparable to those of the highly productive Arabian Sea. New production is known to be coupled with export fluxes on longer time scales, i.e., of sediment traps. The observed high new production

also verifies the earlier conjecture put forward to explain the observed low pCO_2 in the surface Bay.

$\delta^{15}N$ measurements in surface suspended matter of shelf as well as northern offshore Bay of Bengal show signatures of mixing between continental inputs and marine sources. Dilution by the detrital organic material brought in by rivers leads to a consistently lower $\delta^{15}N$. The depth profiles of $\delta^{15}N$ show an increase by a maximum of around 4‰ between the top 60m and 300m indicating the role of higher sinking rates of particles ballasted by aggregates of organic and mineral matter in the Bay.

New production study performed in the Arabian Sea shows an almost five fold rise in the average new production from January (~2.3 mmol N $m^{-2}d^{-1}$) to late February-early March (~12.7mmol N $m^{-2}d^{-1}$). The observed increase may be due to lateral advection of nitrate from a nearby region or due to nitrate entrained during January whose residence time was ~50 days. This nitrate might have sustained the bloom during February-March, once the light conditions became optimum due to waning winter cooling.

The f- ratio during January, in general, shows an increasing trend from the south (off Goa) to the north (off Gujarat), clearly depicting the systematic effect of intensification of winter cooling. Northeast trade winds prevalent in the region during this season bring the cool, dry air and cause an increase in the evaporation and heat loss from the surface, and cooling and consequent increase in the density leading to convective mixing. This results in the deepening of the mixed layer and consequent transport of nutrients from the base of the mixed layer and upper thermocline to the surface, to increase the new production.

The nitrogen isotopic composition of the surface suspended matter reveals an overall increase by ~5‰ in $\delta^{15}N$ in the region from January to March. This increase is possible due to an overall increase in the nitrogen isotopic composition of the source ($\delta^{15}N$) nutrients or due to a change in the fractionation behaviour of the phytoplankton. The analysis of nutrient regime suggests that if the deeper nitrate is the source during both the months, the observed increase may be indicative of an intensified denitrification leading to an isotopic enrichment of the source nitrate. And if the nitrate entrained during January is the source, the continuous uptake by the phytoplankton might have led to an isotopic enrichment observed during March.

The observed new production and f-ratio results can be used to prepare new production maps of the region using satellite data for better spatial and temporal coverage.

Thus this thesis provides a new and comprehensive data set on new and total productions, natural variability of $\delta^{15}N$ in suspended matter for different seasons from the northern Indian Ocean, and helps in gaining insight into their nitrogen and carbon cycles.