CONCLUSIONS AND RECOMMENDATIONS
For nearly two and half decades the nodule deposits in the Indian Ocean have attracted the attention of scientists from this country both for resource potential and basic science of formation of these deposits.

The polymetallic nodules in the CIB have been extensively studied on various aspects and studies include mineralogy, morphology, chemistry and other related aspects such the environment, topography of the region, sediment characteristics, sea bed conditions, nodule potential and distribution.

Although the technology, economic viability and environmental aspects of deep-sea mining of nodules has been under discussion for the last two decades by various Consortia, Countries etc., no concrete results have come out of these discussions and many gray areas do still exist.

There is no systematic documentation on the economic, environmental and feasibility of mining aspects in Indian Ocean.

This work incorporates the results of the studies/ analysis carried out on polymetallic nodules of Indian Ocean with particular reference to the Central Indian Basin (CIB) nodule deposits.

A large exploratory dataset available for the Indian Ocean site was used to arrive at a comprehensive analysis of polymetallic nodules with an emphasis on economic, environmental and mining aspects. This is a first attempt to collate various datasets and develop suitable models for selection of potential sites, and evaluate various mining systems/ technologies, the impact of mining on the environment and understand the demand and supply of the metals that form a resource from nodules.

A large number of stations (n = 435) computed for nodule abundance and grade (Co+Ni+Cu) suggests an inverse relation (r = -0.52) between the two variables.
These results corroborates the earlier findings of inverse relationship between nodule abundance and grade.

The two sets of values considered for the present study include the stationwise values and the blockwise kriged values, and they reflect the difference in the results due to different support and areal extent. Moreover, the stationwise values represent direct measurements, whereas the blockwise values are approximated by a model used for estimation of a variable. Therefore, the stationwise values provide an idea on the distribution of values on a point scale with a limited areal extent (area of influence), and the statistics of blockwise kriged values reflect the distribution of estimated values on a much larger areal scale.

It is observed that the mean values based on stationwise measurements compare reasonably well with the mean values based on blockwise estimates, and the variability of blockwise estimates are considerably reduced when compare to the stationwise measurements. Therefore, the blockwise kriged values have greater reliability due to the optimizing techniques than the direct measurements based on stationwise values.

A model developed based on frequency distribution studies of stationwise and blockwise kriged values suggest using a transformation, $Z = \log x$ or $Z = \log(a+x)$, and the variables such as abundance, grade, Co, Ni, Cu and Mn considered in this study respond to log distribution models. It is therefore approximated by a 2-parameter log normal distribution model. Thus, the frequency distribution models so developed are used for arriving at a suitable selection criteria at block level, for identification of potential areas as well as to demarcate a mine-site in the CIB.

If the selection blocks/areas are based on abundance, then 50% of the samples/area provide an estimated abundance of 9 kg/sq.m. Whereas the selection of area based on grade results in 50% of the samples/area to provide an estimated grade of 2.9%.
The experimental grade-tonnage curves based on stationwise and blockwise values suggest the dependence of the curve on block size. The resultant curve based on stationwise values may be too optimistic and not realizable in mining practices. However, the curve based on blockwise values relate to a larger block size to be considered for acceptance or rejection. The smaller block sizes may provide the desired resultant abundance and grade values of selected blocks and may be reliable and more realizable while mining the nodules.

Based on the analyses of various available technologies for mining and the Indian efforts to develop a reliable mining system, an environmentally safe mining system has been proposed in this study.

The compounded demand growth rate of various metals have been analyzed both for globally and in Indian context. An analysis has also been made on the trends and prices of these metals (Co, Ni and Cu) for the last century. Considering the growth in demand supply and metal prices, the expected level of demand-supply of Co, Ni, Cu and Mn for the year 2020 has been projected.

A cost model has been developed based on the suggested mining technology and process package already developed by India. The cost model finally suggests that the polymetallic nodule mining would be economical by 2015 considering the present price trends of Co, Ni, Cu and Mn.

It is suggested that detailed studies on economics of mining, transportation of nodules from the site in Indian Ocean, and extraction of metals be taken up by researchers based on the demand-supply scenario and prevailing market trends of metal prices.