

## FORAMINIFERAL STUDIES FROM THE WEST COAST OF INDIA : RELEVANCE TO PAGES PROGRAM

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Recent years have seen world wide awareness about climatic changes with special reference to global warming due to green house effect. Rise in sea level and changes in monsoonal rainfall pattern are the significant consequences of such warming. For India it is more necessary to asses the impact of these changes as her economy depends on monsoonal rainfall . Similarly any accelerated rise in sea level will effect large population living near 7000 km. long cost line.

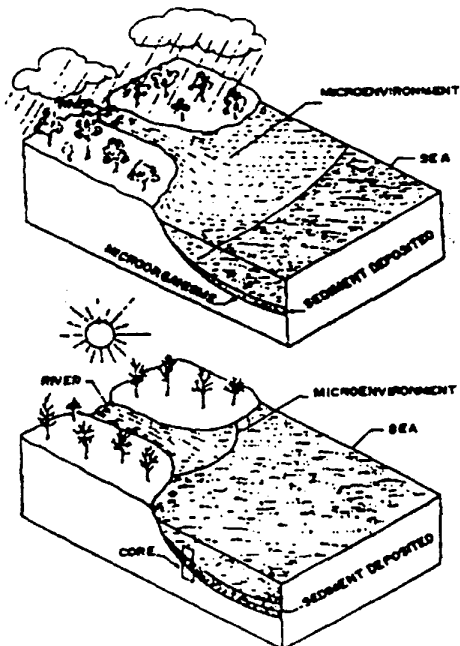


Figure1[a] Good monsoon conditions  
[b] Poor monsoon conditions

To asses the net impact of green house effect we require record of paleo-sealevel changes and paleomonsoonal fluctuations for the last few thousand years and on much finer resolution of time. Such information are prerequisite to understand the climatic systems and the development/testing of reliable long term predictive models.

In recent years, we are studying marine sediments to generate high resolution proxy climatic records and objectively contributed in the field of deciphering changes in paleo-sealevels and paleomonsoons.

We provided conceptual model [Figure 1] and developed techniques of using foraminifera as a proxy to determine the paleoclimates. These studies have enhanced our knowledge about paleomonsoons and sea level changes.

### (a) SEA LEVEL STUDIES

In order to assess accurately the magnitude of suspected future rise in sea level due to global warming, understanding of sea level fluctuations in past is significant.

Development of Techniques: Changes in sea levels can be inferred either by shoreline movement or through depth fluctuations at particular locations. During the

course of investigations, Nigam et al. [*Cont. Shelf Res.*,1993] discovered that barnacle fouling on relict tests can be used as an additional tool for paleoshore line changes. Nigam and Henriques [*Paedogeogr. Paleoclimatol. Paleoecol.*,1992] has also developed a regional model for paleodepth determination which is based on planktonic percentage of foraminiferal fauna in surface sediment of the Arabian Sea. One of the main advantages of the proposed model is that it requires no detailed taxonomic study of the fauna, It is sufficient to separate the fauna into two groups i.e. planktonic and benthic. Preliminary sea level fluctuation curves for the Arabian Sea region can be prepared by using paleobathymetric information through the proposed model. Such information are of immense use to develop predictive models.

**Significant Results:** Nigam et al. [*Curr.Sci.*,1992] has succeeded in demonstrating that as compared to present, sea level was lower by ~100 m about 14,500 years BP. and ~60 m about 10,000 years BP. During the last 10,000 years, three major episodes of sea level fluctuations were also reported [*Current Science*1990, *Mem. Geol. Soc. Ind.*, 1995, *In India's Exclusive Eco. Zone*,1996]. Recent updating of the Holocene sea level curve [ Figure 2 ] for the West Coast of India by Hashimi et al [*Mem. J. Geol. Soc. Ind.*,1999] will serve a long standing need of a standard sea level curve for the future workers.

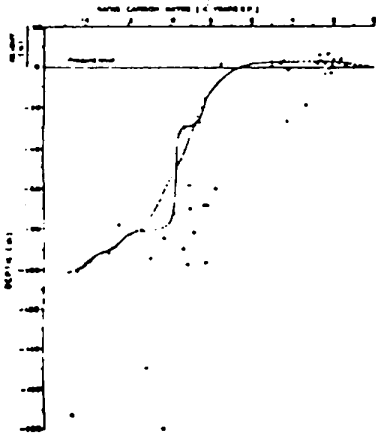


Figure 2 Sea level curve for Central West Coast of India

Till the accurate assessments are obtained about magnitude of rise in sea level, under the DoEn sponsored research, using international figures, the socio-economic implications of anticipated sea level rise due to Greenhouse effect were assessed for Maharashtra, Goa and Karnataka states. Recognition of our expertise in this field came in form of declaration by Govt. of India that NIO will be CRZ authority to clear projects in coastal areas with reference to sea level rise associated with Greenhouse Effect.

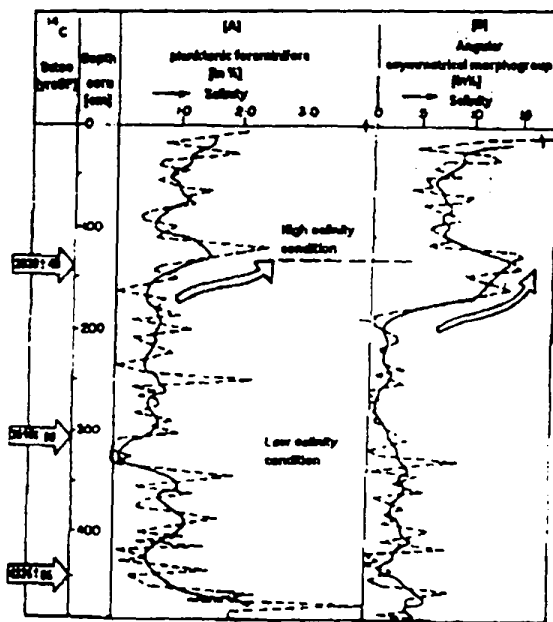
## (b) PALEOMONSOONAL STUDIES

The high resolution proxy records for paleomonsoonal precipitation are the need of the hour over which man's impact could be more easily evaluated. Using foraminifera (marine organisms) in marine sediments as proxy for rainfall, attempts are being made to enhance the understanding of paleomonsoons.

**Development of Techniques :** First, we have evaluated techniques using various parameters like coiling direction [Nigam and Khare, *J.Micropal.*,1992], oxygen isotope[Nigam and Sarkar, *Ind.J.Earth Sci.*,1993] of foraminifera for this purpose. During these studies we have also developed new techniques for determining paleomonsoons. The original idea of using dimorphic variations (mean proloculus

size) in paleoclimatic reconstruction was first published by Nigam (*Paeogeogr. Paleoclimatol. Paleoecol.*, 1986) followed by subsequent publications [Nigam, *Proc. INSA*, 1988; Nigam and Rao, *Est. Coast. Shelf. Sci.*, 1987]. Pursuing this idea further Nigam and Khare [*Geo-Marine Letters*, 1995] established the significance of correspondence between river [Kali in Karwar] discharge and mean proloculus size of benthic foraminifera in paleomonsoonal studies. While studying surface and subsurface sediments off central west coast of India, Nigam et al [*Est. Coast. Shelf Sci.*, 1992 and *J. Geol. Soc. Ind.*, 1994] also found that morphological (coarser morphogroups) variations of benthic foraminifera's response to salinity can be used as additional tool in paleomonsoonal studies. These techniques are simple, less expensive, time saving sorting out samples and adaptable to computer image processing. Development of these techniques helped us to generate high resolution records of paleomonsoons. Since reliability of any new technique can be best supported through culture experiments, a foraminifera culture program was established and preliminary results were published by Nigam et al [*Proc. XV ICMS*, 1996 and *J. Pal. Soc. Ind.*, 1996] and Nigam and Caron [2000]. However, a full program will take couple of years.

**Significant Results :** Studies on core samples off Karwar [Figure 3], west coast of India showed [Figure 2] the clear signals of marked high rainfall around 4000 and 3500 years BP [Nigam and Khare, *In New trends in Arch.* 1992; *Micropaleontology*, 1999; Nigam, *Curr. Sci.*, 1993] and reversal of rainfall condition since 3500 B.P. with a marked low at 2000 years BP [Nigam, *Curr. Sci.*, 1994].



These findings gathered support from palynological investigations of the same core [Caratini et al., *Paeogeogr. Paleoclimatol. Paleoecol.* 1994] and foraminiferal studies off Oman, western Arabian Sea by Naidu [*Curr. Sci.*, 1996]. Nigam [*Curr. Sci.*, 1993] has inferred that monsoonal precipitations were rather high at 280, 840, 1610 & 2030 years before present. Nigam et al [*J. Coastal Res.*, 1995] also deciphered a cyclicity of approximately 77 years in concentrations of drought years and also pointed out the possibilities of correlation between inferred cycle and Gleissberg cycle in variation of radius of the sun. This pilot study when viewed in background of last century rain fall gave a indication in 1989 that coming decades may have good average rainfall [Nigam and Nair, 1989].

Figure 3 -Variation in planktonic foraminifera [A] and angular asymmetrical morphogroup of benthic foraminifera [B] in a core off Karwar

We are now working to provide a regional scenario for rainfall pattern.

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