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# Oceanographic Evidences of the Great Floods in 2,000 and 1,500 BC Documented in Archaeological Records

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### Introduction

According to Grahame Clark, Prof. of Archaeology at the University of Cambridge "*Archaeology may be subtly defined as the systematic study of antiquities as a means of reconstructing the past*" (Archaeology & Society, 1939).

Accordingly, based on the artifacts, a number of climatic changes in the past are documented in archaeological investigations which are reported to have been the causes for the rise and fall of human civilizations. The credibility of such studies increases, if supported by parallel climatic records preserved in the sea.

Nevertheless, the oceans have been a mystery to us until recent times, a source not only of admiration and awe but of confirming speculations of paleoenvironmental conditions mentioned in literature. The unique contribution of the marine sediments has been for deciphering the changes in the oceanographic conditions due to climatic variations in the past. Since the main aim of Oceanography and Archaeology lies in the illumination of the past, it is apparent to bring coherence between the two.

As a model, one such attempt is made in the present study. We have confirmed the major inferences independently drawn through archaeological and oceanographic means about the changes in paleoprecipitaitonal history over the Indian region during the last 4.5 thousand years (A.M.S. dates).

### Paleoprecipitation and Archaeology

In archaeological literature, it has been reported that recurring floods in the neighbouring rivers were the great menance to the Lothal town. One of the floods in circa 2,000 BC ( i.e. about 4,000 years BP) seems to have forced some of the residents of Lothal to move farther interior, to Rangapur, Koth and other places. It is also reported that the Harappans devised several measures to save their township from floods. They could not withstand the onslaught of the second great flood in some of the rivers in Kutch and Gujarat in circa 1,500 BC ( i.e. about 3,500 years BP) [Rao *et al.*,1963]. This indicates that about 3,500 and 4,000 years before present monsoonal precipitation must be very high. This observation is confirmed now by the results

obtained through a recently concluded Department of Science and Technology (D.S.T.) sponsored project on the reconstruction of paleomonsoonal precipitation.

### **Paleoprecipitation and Oceanography**

*Conceptual Model:* Ancient history of paleoprecipitation is contained in layered sediments at the sea bottom which are deposited continuously and can be explored through carefully selected proxy data.

The concept is, that any variation in the intensity of paleomonsoons must have affected the salinity in the near-shore regions, particularly at river mouth sections on the shelf, through river discharge. If any variation existed in the precipitation of the past time, they can be deduced by examining the pulsating variations of the tracers of paleomonsoonal precipitation in a core taken from the adjoining shelf. For the present purpose we have considered river influx as an indicator of monsoonal precipitation.

*Tool:* Foraminifera are almost exclusive marine organism (Boltovskoy and Wright, 1976) having widespread geographic (horizontal) and bathymetric (vertical) distribution in the ocean including marginal marine bodies like estuaries, lagoons, bays, etc. Near river mouth their population varies with changing fresh water river discharge (due to variation in the intensity of rainfall over land), which changes the physico-chemical conditions (especially salinity) at river mouth micro-environment (Nigam, 1988; Nigam and Nair, 1989). Hence they could be a decisive factor to interpret how monsoonal precipitation behaved in the past. With this intention a study of foraminiferal component namely angular-asymmetrical morpho-group of benthic foraminifera and abundance of planktonic foraminifera at close interval in a shallow water marine sediment core, collected from the inner shelf region off Karwar near the mouth of Kali river was undertaken.

*Model Study:* A 4.8 m long core (SK 27B/8) was collected on the board *ORV Sagar Kanya* during her cruise 27B/8 at lat. 14° 49.43' ; long. 73° 59.37' near the mouth of the estuary of Kali river (fig. 1) at 22 m water depth. This core was sampled at 5 cm intervals and a total of 96 samples were obtained.

All samples were washed through a 63 µm sieve and oven dried. About 400–500 specimens of foraminifera from each sample were separated. Relative abundance in percentage of planktonic foraminifera was calculated. A total of 93 species of benthic foraminifera were identified and classified into two morphological groups (following the criterion of Severin, 1983). These groups are (a) rounded-symmetrical (b) angular-asymmetrical, which are on the basis of external test morphology, irrespective of the taxonomic level. Only one group, angular-asymmetrical is considered for interpretation as another one is complimentary to it. Five points moving average is also taken into consideration. However, based on the earlier studies it is well established that angular-asymmetrical forms and planktonic population favour the conditions of

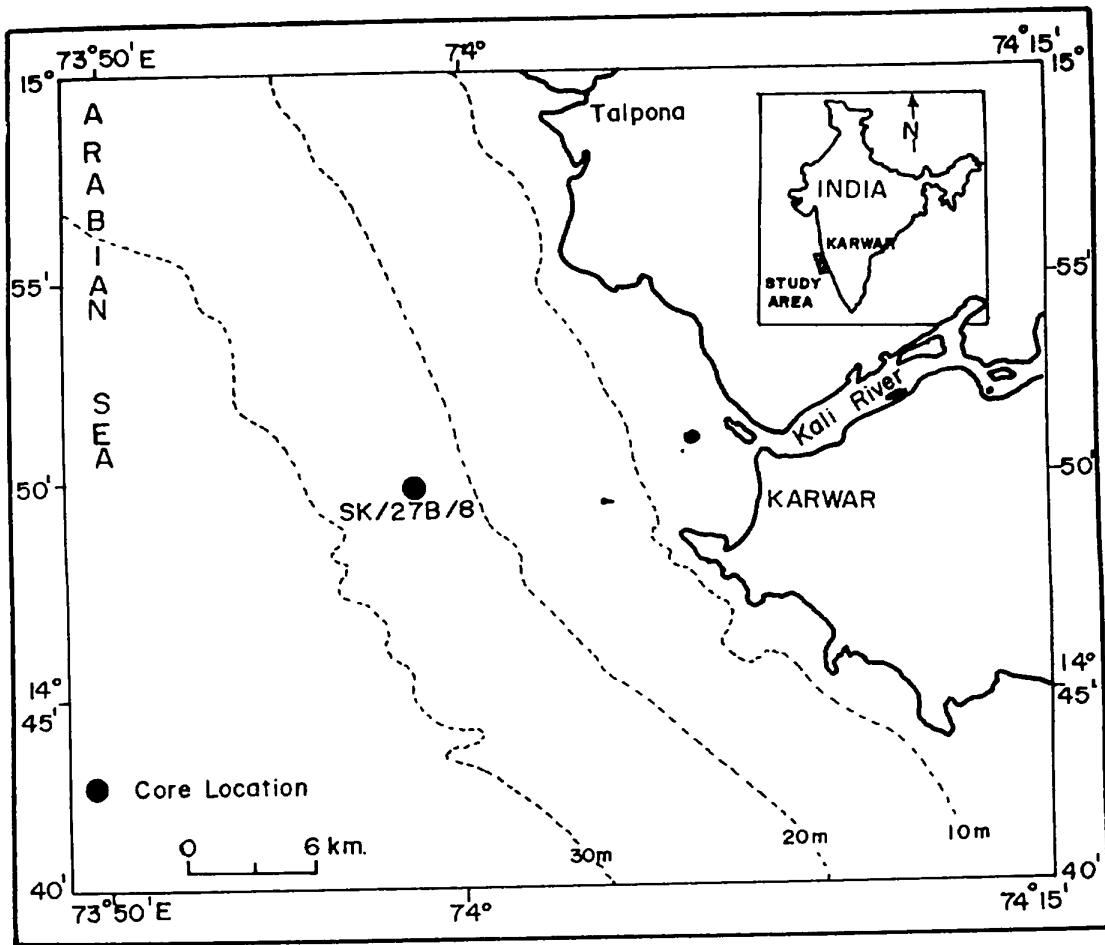


Fig. 1 Location of the core SK 27B/8.

high salinity. As a result of dilution through river discharge during the period of increased precipitation over the catchment area, these parameters get adversely affected. Hence it may be considered that the periods of increased precipitation are accomplished with a diminution of angular-asymmetrical forms (Nigam *et al.*, 1992) and planktonic foraminiferal assemblage (Funnel, 1967; Boltovskoy and Wright, 1976; Lipps, 1979 and Gibson, 1989).

In view of this, the temporal variations in the frequency (in %) of planktonic foraminiferal population and angular-asymmetrical forms of benthic foraminifera were studied down the core.

The results revealed that in general percentage abundance of planktonic foraminifera ranged from 0-4.1. % (fig. 2a) whereas, frequency of angular-asymmetrical morpho-group fluctuated between 0 and 28.85 % (fig. 2b). It has further been noticed that at around 4.00 m and 3.00 m down the core both parameters are showing major troughs (fig. 2).

Based on their ecology and A.M.S. (Accelerator Mass Spectrometry) dates at these levels (marked as A1 and A2 in fig. 2), it may be inferred that at around 4,000 and 3,500 years BP the intensity of the monsoonal precipitation reached its peak. It is tantalizing to note that same periods of high monsoonal precipitation are reported in the archaeological records (Rao *et al.*, 1963).

Record of a relatively increased precipitation at circa 4,000 years BP noticed in this study looks interesting in view of the archaeological evidence in Africa which indicates that cattle and small stock first entered Northern Kenya approximately 4,000 years ago, when rainfall was higher than at present (Owen *et al.*, 1982).

## Conclusions

The findings of this work clearly show the evidences of enhanced monsoonal precipitation around 4,000 and 3,500 years BP and thus supports what has been reported in archaeological literature.

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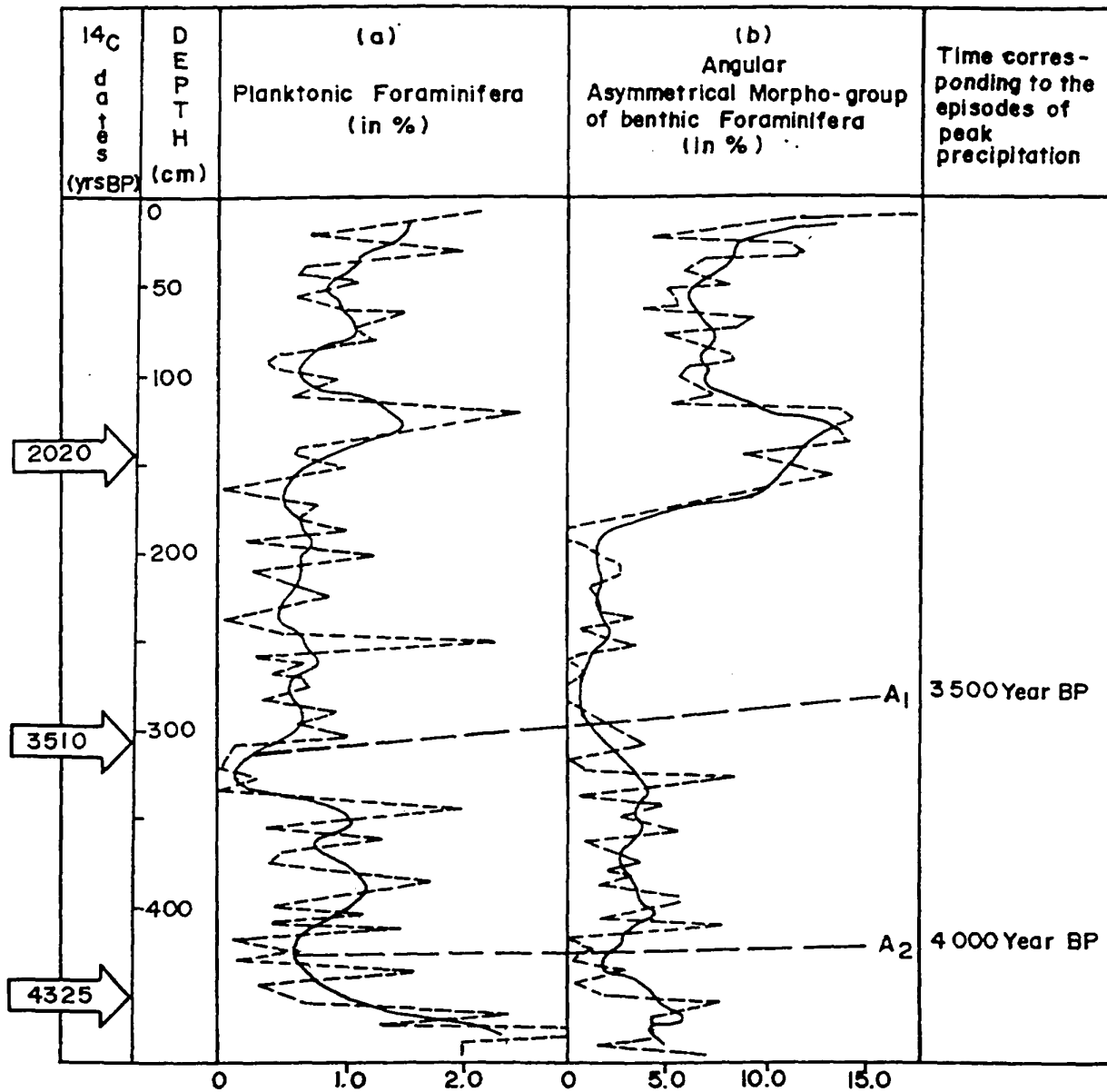


Fig. 2 Down core variations in the frequency (in %) of: (a) Planktonic foraminifera; (b) Angular-asymmetrical forms of benthic foraminifera.

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