

Planktonic Foraminifera from a Quaternary Deep Sea Core from the Southern Arabian Sea

P. DIVAKAR NAIDU, P. S. RAO AND J. N. PATTAN
National Institute of Oceanography, Dona Paula, Goa 403 004

Abstract

An investigation on planktonic foraminifera and calcium carbonate content of a box core collected at a depth of 2556 m from the southern part of the Arabian sea indicates faunal changes depicting Quaternary climatic fluctuations. Based on the study the Last Glacial Maxima (LGM) boundary is placed at 65 cm and below LGM. Three warm and two cold episodes are identified.

INTRODUCTION

Quaternary climate has been studied based on the variation of calcium carbonate content (Damuth, 1975), composition of cold and warm water foraminifera and their coiling direction (Ericson *et al.* 1954; Blackman and Somayajulu, 1966). In recent years oxygen isotopes have been extensively used in understanding climatic events on a global scale. Such studies have mostly been confined to the Pacific and the Atlantic Oceans. Micropalaeontological investigations of the Indian Ocean were carried out largely during the International Indian Ocean Expedition (1960-65) and later by Freriches (1968), Bandy *et al.* (1972), Setty and Guptha (1972), Kameswara Rao (1972), Srinivasan *et al.* (1974), Fleisher (1974), Vincent *et al.* (1974), McGowran (1974, 1978) and Vincent (1976). A few attempts have been made to study the planktonic foraminifera and date them from the shelf region of the Arabian sea (Borole *et al.* 1982). In recent years, a special emphasis is being laid on the study of planktonic foraminifera from the deep sea region to understand climatic pattern during late Pleistocene. The present study reports the variations in faunal composition and calcium carbonate content of a box core collected from the southern Arabian sea.

MATERIALS AND METHODS

A 3 m long sediment box core (30 cm. x 30 cm.) was collected during the 20th cruise of *ORV Sagar Kanya* near Chagos Laccadive ridge from lat. 10°02'N and long. 71°55'E at a water depth of 2556 m (Fig. 1). The core was subsampled on board based on colour variation (Fig. 2a) using USGS standard colour chart and samples were kept in deep freeze. The subsamples were made salt free with deionized water and dried at <60°C in the laboratory. Grain-size analysis was carried out following the method of Folk (1968). Coarse fraction was sieved through 149 µm mesh and >149 µm size fraction was scanned under stereo binocular

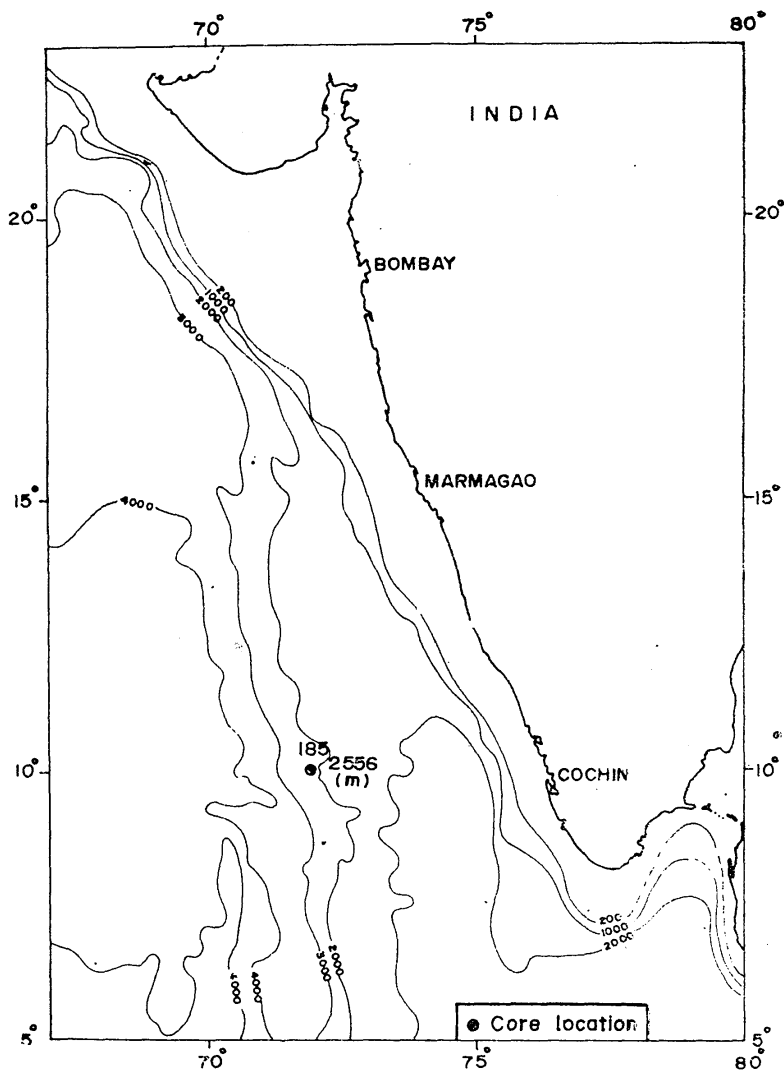


Figure 1. Map showing core location.

microscope for planktonic foraminifera identification and estimation of its relative abundance and percentage of tropical, subtropical, subpolar and polar fauna were calculated. CaCO_3 content was determined using Karbonat Bombe method (Muller and Gastner, 1971).

CORE DESCRIPTION

The core SK-20/185 exhibits laminations at different depths, consists of semi-pelagic and pelagic sediment-dominated by biogenic components with intercalated

terrigenous material. Top 0–15 cm got disturbed during retrieval. The top 0–25 cm of the core represents pelagic yellowish grey foraminiferal ooze. Grain-size analysis shows that coarse fraction is maximum at 20–25 cm interval. Remaining part of the core texturally is silty clay to clayey silt (Fig. 2b).

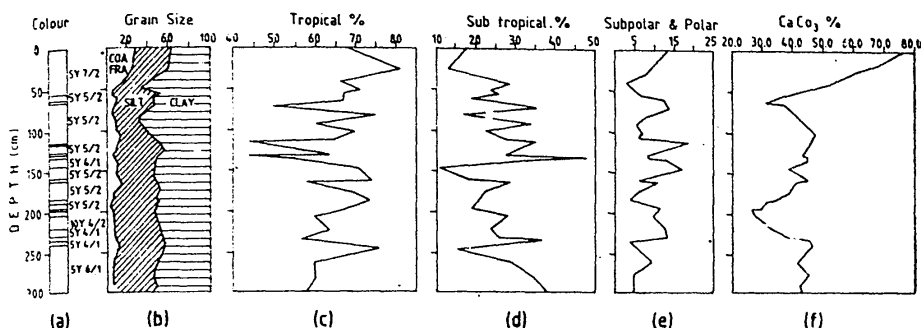


Figure 2. Down core variations of: (a) colour, (b) size fraction, (c) tropical fauna, (d) sub-tropical fauna, (e) subpolar and polar fauna and (f) calcium carbonate content.

RESULTS AND DISCUSSION

Despite the fact that the planktonic foraminiferal population is moderate, it shows modern distribution yielding 19 species as shown below. Based on the ecological characteristic features (Be and Tolderlund, 1971) the foraminifera have been classified into four major groups, viz., tropical, subtropical, subpolar and polar. Down core variation of tropical, subtropical, subpolar and polar faunal composition and calcium carbonate are shown in Figures 2c, d, e and f respectively. In the present study the lone polar species encountered is *Neogloboquadrina pachyderma*. The temperate species are composed of *Globigerina bulloides*, *Globorotalia inflata*, *Globorotalia truncatulinoides* and *Globorotalia quinqueloba*. The tropical and subtropical species are composed of *Globigerinella aequilateralis*, *Globigerinoides conglobatus*, *Globigerinoides sacculifer*, *Pulleniatina obliquiloculata*, *Globigerinoides ruber*, *Globorotalia menardii*, *Globorotalia tumida*, *Globoquadrina conglomerata* and *Candeina nitida*. Since the core is from tropical region, polar and subpolar species abundance is low but follows a definite trend responding to climatic changes. The distribution of tropical, subtropical and subpolar and polar fauna distribution varies from 44–76%, 18–40% and 5–19.5% respectively (Fig. 2c, d, e). The lone polar species *N. pachyderma* is very sparsely distributed (2–3%).

At 20–25 cm interval 80% tropical, 12% subtropical and 8% subpolar fauna were observed with the dominance of *G. ruber* (16.8%) and at 65 cm core depth, 50% tropical, 35% subtropical and 13% subpolar fauna with 33% of *G. menardii* were noticed. *G. bulloides* is the dominant species (16%, 12%) with 42% tropical, 35% subtropical and 20% subpolar at 110 cm and 57% tropical, 30% subtropical and 13% subpolar at 230 cm respectively. At 130 cm 64% tropical, 23% subtropical and 8% subpolar fauna with the dominance of *G. dutertrei* (23%) and at 165 cm, 70% tropical, 20% subtropical and 10% subpolar fauna with 21% of *G. sacculifer* were observed. At 240 cm *G. menardii* (24%) dominated with 77% tropical, 15% subtropical and 8% subpolar fauna.

The calcium carbonate content is maximum (76%) in the top 0–25 cm interval which gradually decreases to 31.26% at 62–65 cm and again increased to 46% at 135 cm. Further down, sharp decrease in CaCO₃ (26%) has been noticed at 198–204 cm interval (Fig. 2f).

It has been well established that the calcium carbonate in Quaternary deep sea sediments fluctuates in response to climatic changes (Damuth, 1975). Ruddiman (1971) and Hays and Peruzza (1972) have noted that the carbonate content is relatively higher during the interglacial than in the glacial sequence and has fluctuated reflecting the Quaternary climatic oscillations.

The variation in distributional pattern of tropical, subtropical, subpolar and polar fauna and calcium carbonate content in the present core may be attributed to climatic fluctuations during Quaternary period. The abundance of tropical fauna (*G. menardii*, *G. ruber*) shows a definite increase in the top 0–65 cm interval and below 65 cm the core was characterized by an increase in the abundance of subtropical and subpolar fauna. This change may be due to the cold condition prevailed during Last Glacial Maxima, which is also supported by decrease in calcium carbonate content at 65 cm. In the Indian Ocean, the Last Glacial Maxima was placed approximately at 18,000 years B. P. (Prell and Hutson, 1979). These observations suggest that the sediment accumulation rate in this region may be of the order of 3.5 cm/1000 years. At 130, 165 and 245 cm. interval, the core is represented by the abundance of tropical fauna, suggesting warm episodes during late Pleistocene period. The abundance of subpolar fauna (*G. bulloides*) at 110 and 230 cm interval indicates colder episodes. The CaCO₃ content also shows high and low values at warm and cold episodes respectively. The increase in the CaCO₃ content in top 25 cm may be due to high productivity in the overlying water column as a result of upwelling during the Holocene period (Nair and Hashimi, 1980). Hence, it may be concluded that the Last Glacial Maxima boundary is placed at 65 cm and during late Pleistocene period (below LGM) three warm and two cold episodes are noticed in the present core.

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There are superficial reasoning men who, without truly knowing what they see, think, they know those regions of the earth which can never be seen, and who judge of the great operations of the mineral kingdom from having kindled a fire and looked into the bottom of a crucible.

JAMES HUTTON