ACKNOWLEDGEMENTS. I thank Prof. K. S. Valdiya, Chairman, Geodynamics Unit, for his valuable suggestions and also Prof. C. N. R. Rao, President, JNCASR for extending the facilities of the Centre during my tenure as a Visiting Scientist on Sabbatical Leave from Mangalore University. Sri G. C. Suresh assisted in the field and laboratory work. Part of this work is the offshoot of a reconnaissance field work along the west coast, undertaken jointly by the researchers of C-MMACS; Colorado, Cochin and Mangalore Universities. The age data for the St. Mary Island shells were provided by Prof. Claudio Vita-Finzi of the University College, London. I am grateful to these individuals and the institutions for their help and support.

Received 16 March 1998; revised accepted 21 July 1998

Radiocarbon dated sedimentation record up to 2 ka BP on the inner continental shelf off Mangalore, south-west coast of India

K. Pandarinath*, A. C. Narayana† and M. G. Yadava*

*Oceanography and Climate Studies Group, Physical Research Laboratory, Navrangpura, Ahmedabad 380 009, India
†Department of Marine Geology and Geophysics, Cochin University of Science and Technology, Fine Arts Avenue, Cochin 682 016, India

Sediment samples at 0–10 cm, 50–60 cm and 90–100 cm depth of a core raised from the innershelf off Mangalore were dated using ^{14}C dating technique to obtain a long term sedimentation record in the region. The surface (0–10 cm depth) of the core showed bomb-induced ^{14}C activity and, hence, were considered as modern sediments. The base of silty-clay (50–60 cm depth) and sandy-clay (90–100 cm depth) layers were dated to 1330 ± 80 and 2090 ± 80 years respectively. The sedimentation rate in the study area has not varied much during the past 2 ka BP, which reveals that the sediment supply and hence weathering conditions at the adjacent interland have remained nearly the same during this period.

SEDIMENTATION rates on the inner continental shelf are essential for understanding the fluctuations in sediment influx, climate, dating events and tracing the influence of industrialization and pollutants. On the western inner continental shelf of India, modern sediment accumulation rates were determined in the surficial sediment (top ~ 5 cm; < 100 years age) off Gulf of Cambay[1,2], Bombay[2], Karwar[3], Mulki[4] and off Mangalore[5] by ^{210}Pb excess method. There are however, very few sedimentation records extending further back in time and they are mainly derived from ^{14}C dating of: (i) core sub-samples (off Karwar[6]) and (ii) a single peat sample that occurred at 2–4 m depth (off Karwar[7] and off Taingapatnam[8]). These sedimentation records reveal that the sediment accumulation rates in the southern parts of the western inner continental shelf of India are considerably lower (2.6–0.12 mm/year) than those of the northern areas (19–5 mm/year) and are highly variable within short distances in the innershelf region. As there is no sedimentation record back to longer period on the innershelf further south of Karwar, we have measured sedimentation rates for the last 2 ka BP by ^{14}C dating of three sediment sub-samples in a core off Mangalore.

The continental shelf off Mangalore contain surficial sediments of clayey-silts/silty-clays at < 50 m and sands from 50 to 100 m water depths[9]. A gravity core, 1 m long was raised from the innershelf off Mangalore in 41 m water depth at 12°46.6'N and 74°39.6'E (Figure 1) during the 207th cruise of *R.V. Gaveshani*. Rivers Nethravati and Gurpur, which meet the sea at Mangalore, are the main sources of terrigenous material to the study area. These rivers discharge annually 12,015 and $2,822 \times 10^6$ m^3 water and 14 and 1×10^5 tonnes of sediment respectively into the adjacent Arabian sea[10].

Sand, silt and clay percentages in the sub-samples (10 cm interval) were determined by standard wet-sieving and pipette analysis method[11] and sediment nomenclature was based on the procedure of Shepard[12]. Radiocarbon dating of organic matter in the samples was carried out using the procedure described by Gupta and Polach[13]. The carbon in the organic matter of the sediments was converted into benzene. Radiocarbon activity of the benzene was measured by Liquid Scintillation Counter 'QUANTULUS'. Ages were determined based on half-life period ($t_{1/2}$) of 5730 years for ^{14}C. The errors mentioned with the obtained ages are at 1% (one standard deviation) level.

Based on variation in sediment texture, the core can be divided into two layers: (i) silty-clay, 0–60 cm depth with 7.3–16.2% of sand, 23–28.5% of silt and 57.8–66.7% of clay; (ii) sandy-clay, 60–100 cm depth with 21.4–25.2% of sand, 12.2–18.6% of silt and 58.0–65.2% clay. Based on this observation, surface of the core (0–10 cm), base of the silty-clay layer (50–60 cm) and bottom portion (90–100 cm depth) of the core were selected for the age determination. Owing to insufficient quantity of the samples, 10 cm length of the core was taken as a sub-sample.

The surface of the core (0–10 cm) showed $117 \pm 1\%$ ^{14}C activity which indicates the influence of bomb-induced ^{14}C activity. Hence, the sediments of 0–10 cm depth were considered as modern. The base of silty-clay layer (50–60 cm depth) and sandy-clay layer (90–100 cm depth) revealed an age of 1330 ± 80 and 2090 ± 80 years respectively (Figure 2). The grain-size distribution within

†For correspondence.

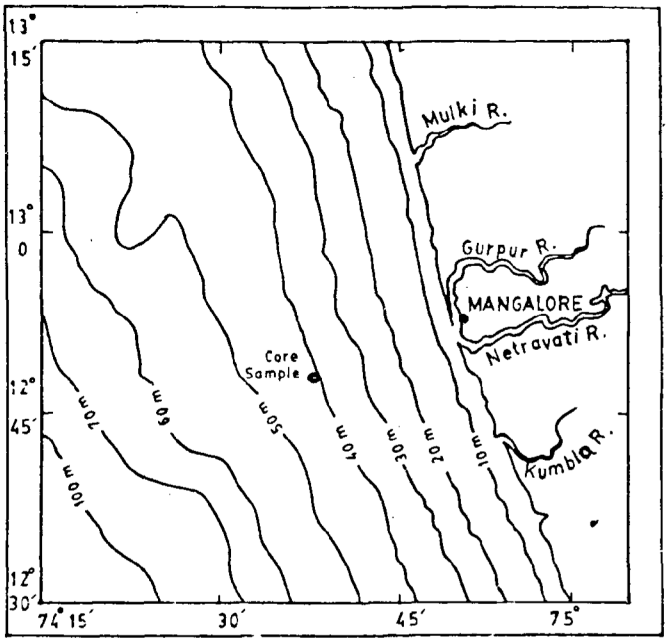

Figure 1. Location of the core and bathymetry of the study area.

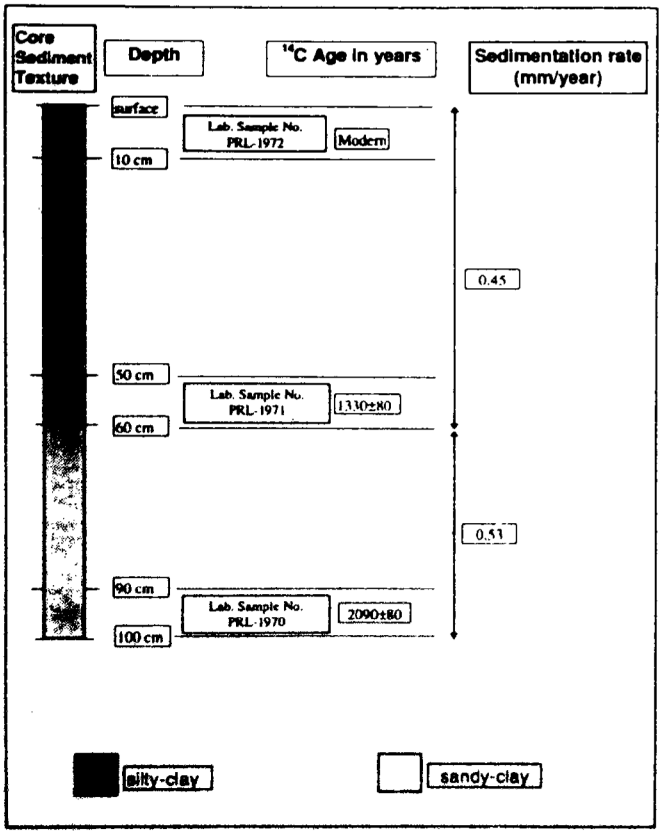

Figure 2. Sediment texture and chronology of the core.

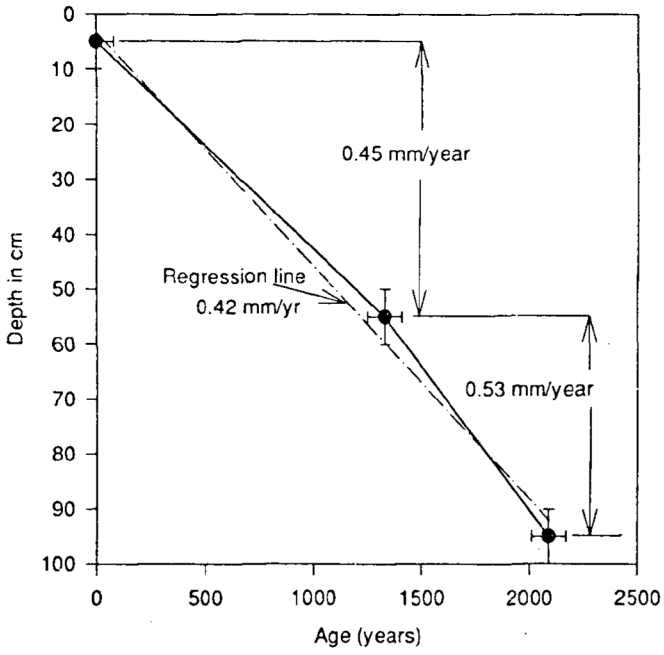

Figure 3. Depthwise variation in the sedimentation rate.

the layers did not vary much. Therefore, as a first approximation, it was assumed that the variations in sedimentation rate, if any, within these layers were negligible and average sedimentation rates for the layers were computed. The chronology gives two different sedimentation rates; 0.45 mm/yr from 0 to 60 cm and 0.53 mm/yr from 60 to 100 cm. However, the difference in these sedimentation rates is very small. Hence, an average sedimentation rate computed for the entire core length can be used for the inferences. The slope of the regression line has given the average sedimentation rate, for the entire core, as 0.42 mm/yr (Figure 3). Manjunatha and Shankar[5] have dated the top 6 cm of two cores in the same region by excess ^{210}Pb dating technique to compute the present day sediment accumulation rates. They have reported an accumulation rate of 0.56 mm/year and 0.72 mm/year for modern sediments (top 6 cm) at water depths of 45 and 35 m respectively. The long term average sedimentation rate obtained in this work is comparable to that of present day (or for the past century) sedimentation rate (0.56 mm/year) obtained in the adjacent core (at 45 m water depth) by Manjunatha and Shankar[5]. However, the higher sedimentation rate (0.72 mm/year) at 35 m water depth[5] was expected as it is comparatively near to the river mouth than the present study area.

The innershelf sediments are mainly input of the rivers draining through the adjacent interland and mixing of these with the deeper marine sediments is negligible in the innershelf[14]. Hence, the sedimentation rate on the innershelf, near the river mouth, reflects the erosion processes operating in the adjacent interland and sediment

load carrying capacity of the rivers. In the present study, the rate of sedimentation has not varied much during the last 2 ka BP. This suggests that the sediment supply to the region and hence weathering conditions at the adjacent interland have not varied much during the last 2 ka BP. This observation is also supported by the palaeoclimatic studies which show that there is no significant climatic changes in the south-western[6] and north-western India[15–17] during this period.

1. Borole, D. V., Sarin, M. M. and Somayajulu, B. L. K., *Indian J. Mar. Sci.*, 1982, **11**, 51–62.
2. Borole, D. V., *Mar. Geol.*, 1988, **82**, 285–291.
3. Nigam, R., Khare, N. and Borole, D. V., in Proceedings of International Symposium on Oceanography of Indian Ocean, NIO, Goa, vol. of abstract, 1991, p. 57.
4. Karbassi, A. R., Ph D thesis, Mangalore University, 1989, p. 196.
5. Manjunatha, B. R. and Shankar, R., *Mar. Geol.*, 1992, **104**, 219–224.
6. Caratini, C., Fontugne, M., Pascal, J. P., Tissot, C. and Bentaleb, A., *Curr. Sci.*, 1991, **61**, 669–672.
7. Nambiar, A. R., Rajagopalan, G. and Rao, B. R. J., *Curr. Sci.*, 1991, **61**, 353–354.
8. Nambiar, A. R. and Rajagopalan, G., *Curr. Sci.*, 1995, **68**, 1133–1137.
9. Hashimi, N. H. and Nair, R. R., *J. Geol. Soc. India*, 1981, **22**, 266–273.
10. Karnataka Irrigation Department, River discharge data No. 5. Gauging Sub-Div., Shimoga, India, 1986, (unpubl.).
11. Carvar, R. E., *Sedimentary Petrology*, John Wiley and Sons, London, 1971, p. 653.
12. Shepard, F. P., *J. Sediment. Petrol.*, 1954, **24**, 151–158.
13. Gupta, S. K. and Polach, H. A., *Radiocarbon Dating Practices at ANU*, Hand Book, Radiocarbon Laboratory, Research School of Pacific Studies, ANU, Canberra, 1985, p. 173.
14. Pandarinath, K. and Narayana, A. C. (unpublished data).
15. Singhvi, A. K., Dhir, R. P. and Rajaguru, S. N., *Mem. Geol. Soc. India*, 1989, **16**, 1–4.
16. Chawla, S. N., Dhir, R. P. and Singhvi, A. K., *Quat. Sci. Rev.*, 1992, **11**, 25–32.
17. Prasad Sushma, Kusumgar Sheela and Gupta, S. K., *J. Quat. Sci.*, 1997, **12**, 153–159.

ACKNOWLEDGEMENTS. One of the authors (A.C.N.) thanks the Director, NIO, Goa, for the cruise facilities provided on board *R.V. Gaveshani*. Thanks are also due to Dr Sheela Kusumgar, PRL for her guidence during radiocarbon dating.

Received 19 March 1998; revised accepted 14 July 1998