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# Distribution of Organic Carbon in Sediments of the North Western Continental Shelf of India

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Organic carbon in the sediments varies from 0.24 to 2.42% (av. 0.95%) which is far below the world average for the nearshore sediments. Fine grained terrigenous sediments of the shelf off Saurashtra coast and those in the inner shelf between Bombay and Port Dabol are characterised by relatively high organic carbon content (>1%); fine grained sediments of the inner shelf between Gulf of Cambay and Bombay and the shelf between Indus canyon and Gulf of Kutch and the coarse grained carbonate relict sediments on the outer shelf are characterised by low organic carbon content (<1%). Differences found in the organic carbon contents of the fine grained sediments of different regions can be traced mainly to the differences in the productivity of the overlying waters. Although in the outer shelf regions also, areas of high and low productivity are encountered, the low organic carbon content in these sediments appears to be due to a combination of several factors—coarse grained nature of the sediments, relatively low rate of sedimentation and lack of enough fine grained terrigenous material for the protection and preservation of organic matter in the sediments. The generally low organic carbon content recorded in this area when compared to world average for the shelf sediments, can be attributed to the oxidation because of high dissolved oxygen content of bottom water or grazing by zooplankton and other higher organisms.

During the cruises of *INS Darshak* (December 1973-May 1974) in the north eastern Arabian Sea, bottom sediment samples were collected from 14 sections normal to the coast (90 stations) on the continental shelf between Indus canyon in the north and Port Dabol in the south. Samples from 76 stations only were analysed for organic carbon content. The samples were collected between 20 and 100 m depth while 1 sample was collected from 250 m depth using a La Fond-Dietz snapper.

The present study of distribution of organic carbon in the sediments forms a part of the comprehensive study of the geochemistry of these sediments at the Institute. The results obtained are discussed in relation to the distribution of sediments and the hydrographic features. The distribution of organic matter and $CaCO_3$ in the sediments of the shelf has been described earlier but all the previous studies are based on limited samples[1-8]. Rao[9] has studied in detail the distribution of the $CaCO_3$ in the study area and his results are used here to depict the nature of the sediments.

## Methods

A portion of representative sediment sample from each station was washed free of chloride with distilled water, dried at 60 to 70° and pulverised. An aliquot of this powder was taken and organic carbon determined following the method of EL Wakeel and Riley[10].

## Results and Discussion

Organic carbon and the calcium carbonate contents at each station are shown in Fig. 1, while the texture[11] of the sediments is shown in Fig. 2. The following observations are made from Fig. 1: (i) Organic carbon content in the sediments varies from 0.24 to 2.24% corresponding to 0.42 to 3.86% of organic matter. (ii) Average organic carbon content of 0.95% corresponds to only 1.64% organic matter which is far below the world average of 2.5% for the nearshore

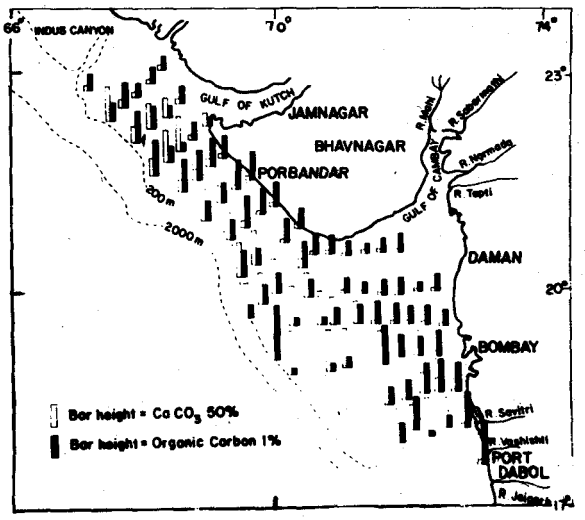


Fig. 1—Percentages of $CaCO_3$ (after Rao[9]) and organic carbon in the shelf sediments

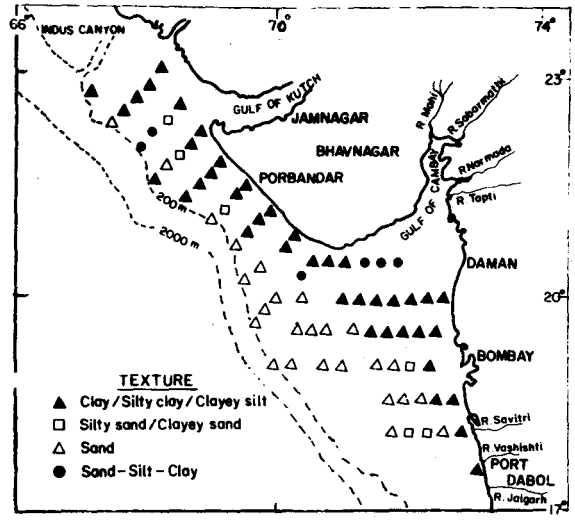


Fig. 2—Texture of the sediments (the nomenclature used is that of Shepard)

Table 1—Primary Productivity at Different Stations

| Region | No. of stations | Range values of column productivity* mgC/m²/day |
|---|---|---|
| Shelf between Indus canyon and Gulf of Kutch | 3 | 234-546 |
| Shelf off Saurashtra | 3 | 1036-2666 |
| Shelf between Gulf of Cambay and Bombay | | |
| Inner shelf | 3 | 382-558 |
| Outer shelf | 4 | 983-1339 |
| Shelf between Bombay and Port Dabol | | |
| Inner shelf | 2 | 1162-1577 |
| Outer shelf | 4 | 109-243 |

*Radhakrishna[14]

sediments[12]. (iii) Organic carbon content of the sediments indicates a definite relationship with the texture and depth. With a few exceptions, high calcium carbonate coarse grained sediments, sands and silty or clayey sands of the outer shelf (> 60 to 65 m water depth) are characterised by a low organic carbon content (< 1%). As against this the fine grained sediments off the Saurashtra coast and those of the inner shelf region between Bombay and Port Dabol are characterised by a higher organic carbon content (> 1%) while those in the other regions, i.e. the sediments of the shelf between Indus Canyon and Gulf of Kutch and the inner shelf between Gulf of Cambay and Bombay are characterised by low organic carbon content (< 1%).

The factors that favour a high organic carbon content in bottom sediments are: (i) abundant supply of organic matter in the overlying waters, (ii) relatively rapid accumulation of fine grained terrigenous inorganic matter, and (iii) low oxygen content of the bottom waters[13].

Before explaining the variations in the organic carbon content in the sediments it would be worth while to examine the above factors in the area.

*Organic production*—Primary productivity was measured by $^{14}C$ technique in 19 stations on the shelf (Table 1). The regional variations in the primary production rates are clearly seen. The waters of the shelf off Saurashtra coast, the outer shelf off Bombay and the inner shelf between Bombay and Port Dabol are characterised by high productivity while the other regions are characterised comparatively by low productivity.

*Rates of terrigenous sedimentation*—Rates of sedimentation for the western shelf are not known. However, distribution patterns of the sediments, i.e. the presence of fine grained sediments with low $CaCO_3$ in the inner shelf region and the high calcium carbonate coarse-grained relict sediments in the outer shelf region, suggest that the inner shelf is characterised by comparatively higher rates of sedimentation than the outer shelf. Murty *et al.*[1] described the fine grained sediments of the inner shelf between Port Dabol and Saurashtra as mostly composed of terrigenous material. The distribution of calcium carbonate indicates that the outer shelf between Gulf of Cambay and Port Dabol is relatively free from terrigenous sedimentation.

*Dissolved oxygen in bottom waters*—From the distribution of dissolved oxygen in bottom waters (about 5 m above the sea bottom)[15] it is seen that (1) the waters of the inner shelf between Bombay and Gulf of Cambay and the shelf off Saurashtra coast and further north are characterised by higher values of dissolved oxygen, (2) the distribution is patchy and the concentration varies from 1 to 4 ml/litre in the waters of inner shelf between Bombay and Port Dabol, and (3) the waters of large area of the outer shelf between Gulf of Cambay and Port Dabol are characterised by oxygen concentrations of < 1 ml to 1-2 ml/litre dissolved oxygen while in a small portion the dissolved oxygen increases to 2-3 and 3-4 ml/litre.

Distribution of organic carbon in the sediments of the inner shelf extending from Port Dabol to Gulf of Cambay and the shelf off Saurashtra and Kutch indicates a relationship with the productivity of waters. The regions of higher productivity are underlain by sediments with higher organic carbon content while the regions of comparatively low productivity are underlain by sediments with a low organic carbon. In view of the similar texture of the sediments and the high dissolved oxygen content of

waters, the differences in the organic carbon content of the fine grained sediments of the inner shelf could only be attributed to the differences in productivity of the waters. The outer shelf is characterised by areas of high and low productivity and the bottom waters to a large extent by lower concentrations of dissolved oxygen. However, the outer shelf sediments are marked by uniformly low values of organic carbon. Because of low sedimentation rates it is possible that the organic matter produced is oxidised in the water column itself. This is partly supported by the high nutrient content in the bottom waters of the region[16].

Comparative study of the organic carbon of these sediments with those of the areas such as southern half of the western continental shelf of India[1], continental shelf of the west coast of Africa[17] and the continental shelf off Peru coast[18] which have been associated with strong upwelling and high biological productivity, has indicated that the organic carbon content values of the sediments of the investigated area are far less than the values reported from other 3 areas. This low organic carbon content could be due to oxidation of the organic matter because of high dissolved oxygen content or grazing by zooplankton and other higher organisms. The latter is more probable in view of the higher zooplankton biomass recorded in this region[19]. The fact that beneath the biologically productive surface waters there could be sediments with little organic matter is well exemplified by the studies of Summerhayes *et al.*[20] on the sediments of Southeastern Brazil, where absence of organic matter in the sediments was attributed to the high degree of oxygenation of upwelled water.

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