

Organic Matter Distribution in the Continental Shelf Sediments, off Kochi, West Coast of India

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ABSTRACT

Organic matter was analysed on the silt-clay fraction of forty eight sediment samples from the continental shelf off Kochi, west coast of India. It was found to be high in the recent, near shore silt-clay predominant sediments towards Alleppey (average 3.8%) than those towards Azhikode (average 1.97%). The sand predominant offshore relict sediments contain very low organic matter values (average 0.71%).

The high organic matter content in the inner shelf is mainly controlled by the fine texture of the sediment in conjunction with other parameters like primary production in the overlying waters, terrestrial organic detrital supply and alongshore currents indicating present day deposition. The low amount of organic matter in the outer shelf may be due to existing high energy non-depositional conditions for the settlement of fine sediment, high dissolved oxygen in the overlying waters and sandy texture of the sediment representing mid-Holocene deposition.

INTRODUCTION

The area under investigation forms a major part of the continental shelf of the Kerala coast from Pallipuram in the north to Alleppey in the south (Fig. 1). The waters of the Vembanad lake are connected to the Arabian sea by an opening at the Kochi harbour channel and at Periyar river confluence, where the northern branch of the bifurcated Periyar river debouches into the sea. The southern branch of the river empties into the Vembanad lake at Eloor. Various other rivers like Muvvathupuzha, Manimala, Meenachil, Pamba and Achankovil empty into the southern half of the lake.

Wiseman and Bennett¹ were the first to report a few values of organic matter in the Arabian sea followed by Stewart et al². Murthy et al³, reported on the organic matter content in

the sediments of the west coast of India on a few selected samples collected on profiles perpendicular to the coast. Later Paropkari⁴ reported in detail the organic matter content of the north western shelf sediments. Prakash Babu et al⁵. re-analysed selected samples from Western Continental Margin of India for organic carbon by coulometry and indicated the importance of bio-productivity for organic carbon accumulation. The work reported so far was based mainly on widely spaced samples covering entire west coast of India. Hence, it was planned to carry out detailed sampling in a specific area to identify the parameters supporting organic carbon accumulation. Organic matter in the present study is also used as a tool to identify the recent-relict sediment zones. In all 48 surface sediment samples were analyzed for organic carbon.

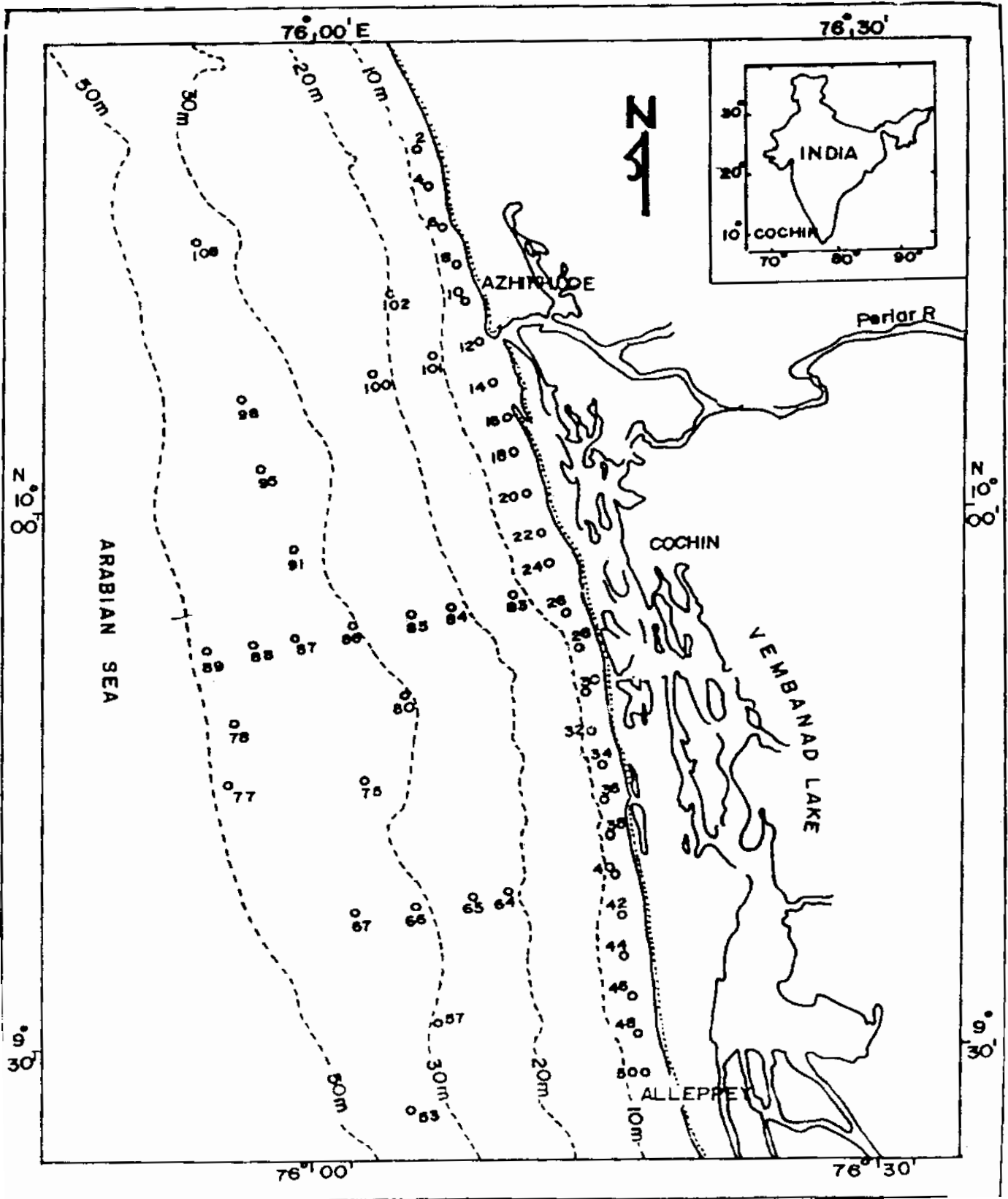


Fig. 1. Map showing sample locations.

Table 1

St. No Nearshore	Depth (M) (Recent)	Mean (ϕ)	Dissolved Oxygen in bottom waters (ml/l)	Organic Matter %
2	8	8.59	3.0	2.59
4	9	7.56	2.8	2.71
6	8	5.15	2.8	1.29
8	9	6.82	2.2	2.65
10	8	5.31	2.6	1.85
12	8	5.67	1.4	1.77
14	9	5.88	2.3	2.72
16	9	4.79	1.9	1.03-
18	9	7.29	2.3	2.72
20	9	5.98	2.6	1.69
22	8	6.94	2.2	1.72
24	7	8.70	1.4	1.89
26	11	6.19	2.3	1.95
28	10	4.31	1.9	1.06
30	9	6.66	2.3	2.60
32	12	6.70	2.5	2.73
34	9	5.70	2.8	3.68
38	8	6.10	2.9	3.46
40	8	6.70	2.5	3.97
42	8	7.10	2.8	3.99
44	7	5.20	2.6	2.37
46	7	6.70	2.9	2.29
48	6	7.70	3.2	3.00
50	7	6.70	3.2	2.73
64	22	6.20	-	3.50
83	16	10.00	4.3	2.35
84	22	6.90	4.8	3.26
100	22	8.00	-	3.65
101	14	7.70	4.7	2.44
102	20	6.20	3.6	2.86

Contd....

St. No Nearshore	Depth (M) (Recent)	Mean (ϕ)	Dissolved Oxygen in bottom waters (ml/l)	Organic Matter %
Offshore (Relict)				
53	35	3.90	7.6	0.98
57	31	3.00	6.0	1.74
65	26	0.90	-	0.28
66	34	1.90	-	0.39
67	42	4.50	-	1.03
75	31	3.70	6.0	1.36
77	48	3.00	4.2	1.31
78	47	3.30	-	0.65
80	30	3.00	7.1	0.10
85	25	6.20	2.8	1.84
86	28	2.50	-	0.38
87	36	4.10	2.5	1.81
88	44	4.50	2.5	3.13
89	48	3.00	3.4	0.80
91	35	5.10	5.8	0.54
95	38	4.00	5.9	0.08
98	34	4.30	6.0	0.08
108	35	4.80	5.3	0.21

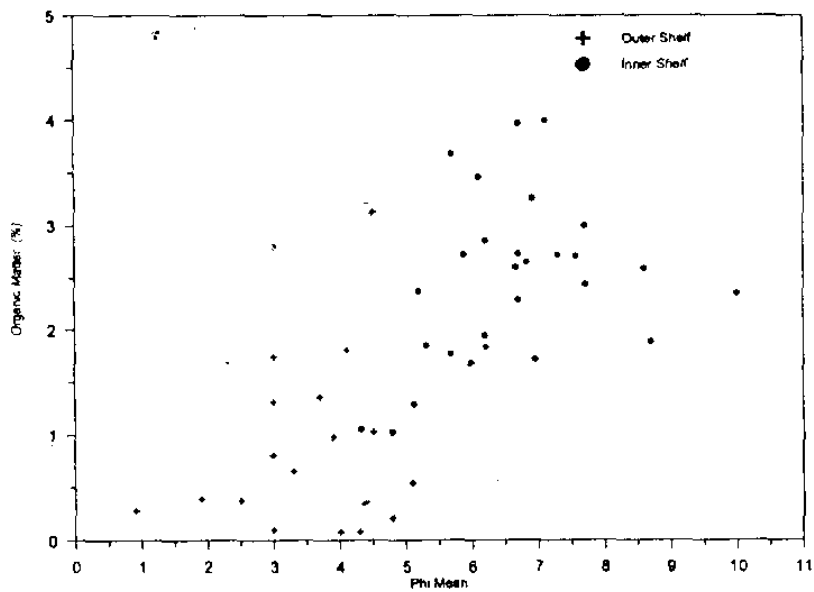


Fig. 2. Organic Matter Vs Mean (ϕ) grain size.

MATERIALS AND METHODS

Sediment samples were collected by Peterson and Van Veen grabs on R.V. Nautilus of the University of Cochin. Near bottom water samples were analyzed for dissolved oxygen in the laboratory by Winkler's method. The silt-clay fraction was separated from sediments after washing free of salts. The silt-clay fractions were dried and pulverized. The organic carbon was estimated titrimetrically following Elwakeel and Riley⁶. These values were multiplied by 1.724 to obtain organic matter following Trask⁷. Grain size studies were carried out by combined sieve-pipette analyses of Krumbein and Pettijon⁸.

RESULTS AND DISCUSSION

The organic matter content in the near shore sediments (up to 30m water depth) varies from a minimum of 1.03% to a maximum of 3.99% (Table 1). The values are low from off Azhikode to Kochi (ave. 1.97%) and further south high values are noticed (ave. 3.08%). The organic matter content in the offshore (beyond 30m water depth) sediments is very low ranging from 0.8 to 1.74% with an average of 0.71%. These sediments are sand predominant with little silt and negligible clay and occurs from a depth of 30 m. These sand predominant samples are from the mid-Holocene strandline deposit⁹ that extends continuously all along the study area parallel to the coast from Azhikode to Alleppey.

The quantity and nature of the organic matter in a deposit are related to the environmental conditions of deposition. The factors that contribute to organic matter are the supply of organic matter, the rate of deposition and the movement of the water and the texture of the sediments. The west coast of India has been known to have seasonal upwelling¹⁰, the process by which bottom nutrient waters are brought to surface resulting in a high primary production. A high production of phytoplankton was also reported in this area¹¹. The sediments of the inner

shelf (beyond 30m water depth) are recent and more or less silty clays to clayey silts, and exhibit a wide range (4.0 ϕ to 10 ϕ) in phi mean size. While those of offshore area are relict silty sands and sands⁹ of mid-Holocene with a phi mean size from 0.9 ϕ and 6.20. Organic matter content show a positive relationship to phi mean size of the sediment (Fig. 2). Increase in organic matter is found with an increase in phi mean size, suggesting that organic carbon is predominantly absorbed by clay particles. This also supports the view that the physical characteristics such as the texture of sediment influence to some extent the accumulation of organic matter in the sediments.

The Vembanad lake, which exists throughout the study area, parallel to the coast is fed by various rivers which originate in the Western Ghats having dense vegetation. This lake seems to be augmented by sewage, the whole area is densely populated, and other pollutants discharged into the region due to movement of ships in and out at the Kochi harbour. Therefore, it is considered that the high values of organic matter in the inner shelf sediments may be the result of out flow of the river laden heavily with terrestrial organic detritus. It is reported¹² that the mangrove ecosystems of Kochi contain 3.7% organic carbon and their distribution pattern is regulated by the particle size. However, it may also be due to the upwelled nutrient rich waters resulting in high productivity in the overlying waters and fine texture of the sediment preserving the depositional organic matter. According to Paropkari et. al.,¹³ the productivity in Arabian Sea is not an ultimate control for the organic enrichment of bottom sediments but it is the bottom water anoxia in conjunction with various depositional parameters such as texture of sediments, rates of fine terrigenous sediment deposition, bottom currents and absorption capacity of individual clay minerals which determine the degree of deposition. Contrarily Prakash Babu et al.⁵ stressed the importance of bioproductivity over other parameters

for the organic carbon accumulation on the Western Continental Margin of India.

In the outer shelf the sediments are mainly sands of mid-Holocene strandline with little silt and negligible clay, with very low organic matter content. It is assumed that the area is devoid of deposition of fine sediments may be due to current activity. It may be that the sandy texture of the sediments and high dissolved oxygen content in the near bottom waters in the region are favourable for the waters to permeate through the sands and oxidise the organic matter deposited from the overlying waters. Dissolved oxygen (ml/l) in the near bottom waters of the nearshore stations varies from 1.4 to 4.8 ml/l (ave. 2.74ml/l) and those of offshore from 2.5 to 7.6 ml/l (ave. 5.01 ml/l) (Table. 1). No. definite relationship could be noticed in the nearshore sediments when dissolved oxygen is plotted against organic matter content (Fig. 3). However, in the outer shelf sediments a trend of decrease in organic matter content is noted with an increase in the dissolved oxygen content. Similarly low organic carbon values in the sediments of the northwestern continental shelf of India have been attributed to the high dissolved oxygen content of the waters⁴.

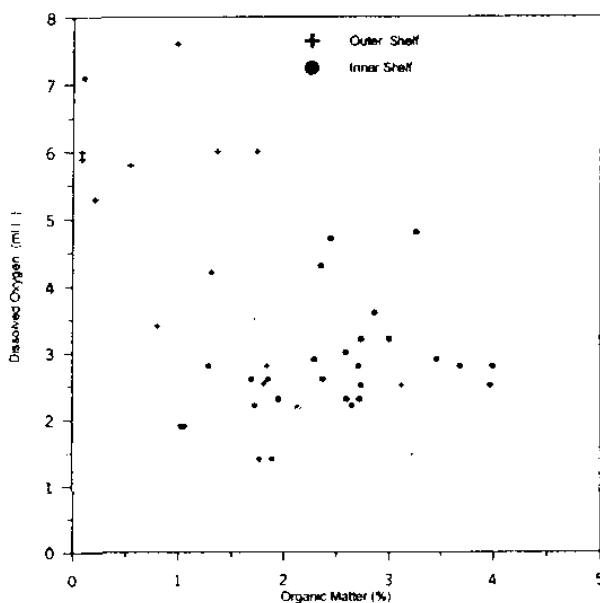


Fig. 3. Organic Matter Vs Dissolved Oxygen.

The enrichment of organic matter towards Alleppey in the inner shelf may be due to the fact that the modern sediments heavily laden with organic detritus of the Periyar river¹⁴ and Vembanad lake are carried south by alongshore currents¹⁵, thereby preventing the sediments from reaching the outer shelf, resulting in its deposition and ultimately preserving the organic matter. Fine sediments do not permeate oxygenated water through them, resulting in a reducing environment and preventing the decomposition of organic matter. Paropkari et. al.,¹⁶ from an overall study of the western continental margin of India suggest that higher organic input, mainly of terrigenous nature as indicated by C/N ratio, protection of absorbed organic matter from oxidation by the fine nature of the sediments and higher rates of fine terrigenous deposition could lead to the preservation of organic carbon.

In summary, the high total organic carbon in the inner shelf is mainly controlled by the fine texture of the recent sediments in conjunction with other parameters such as detrital organic supply, and productivity in the overlying waters. While the low organic carbon content in the offshore relict sediments may be due to existing high energy conditions, alongshore currents, high dissolved oxygen content and sandy texture of the sediment.

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