

Distribution of Some Biochemical Compounds in Sediments of the Shelf & Slope Regions of the West Coast of India

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Thirty-four sediment samples, collected from the Arabian Sea, were analysed for their composition of organic matter. The study revealed high concentrations from the continental slope, whereas continental shelf samples were characterized by low contents of organic carbon, total nitrogen and carbohydrates. Direct relationship was observed between organic carbon-nitrogen and organic carbon-carbohydrate.

ORGANIC matter in sediment is fairly complex in composition. In addition to the remains of living organisms, it includes various constituents produced as a result of the action of various agents on the original living matter. By virtue of this, the organic matter that accumulates in sediments does not, in essence, contain any component of original living matter which has not been modified to some extent. It includes various pigments (chlorophyll-like compounds and carotenoids) lipid-like substances, bitumens, various carbohydrates and a number of nitrogenous compounds.

Although the composition of organic matter in marine sediments has been a subject of study for several decades, there are only isolated instances of detailed analyses¹⁻³. As pointed out⁴, knowledge of the nature of origin and transportation of organic matter in marine sediments may provide valuable information on the sedimentary environment, formation of petroleum, cycling of nutrients and chemical activities of marine organisms.

It is, however, extremely important to make a detailed study of the composition of organic matter of recent sediments and, therefore, of potential energy which it contains if one is to clarify the knowledge of sedimentation and diagenesis processes.

Almost nothing is known except for a few reports on the distribution of organic content⁵⁻⁷ and about the chemical composition of the recent sediments of the Arabian Sea. Therefore, the present work has been undertaken to study the biochemical composition of the recent sediments of the Arabian Sea.

Materials and Methods

Sediment samples from the shelf and the slope regions were collected at 34 stations along 2 transects (Fig. 1) using La Fond-Dietz snapper and Van Veen grab. The samples, essentially representing the top few inches of deposit were immediately frozen at -5°C . Before analyses, samples were thawed, air dried and ground to fine powder and the sediment powder was used for the estimation of organic carbon⁸, total nitrogen⁹ and carbohydrate¹⁰. The amount of organic matter was obtained by multiplying the organic carbon values by a factor 1.724.

Results and Discussion

The results are presented in Table 1. Concentrations of organic carbon (13.2-62.0 mg/g), total nitrogen (1.2-6.36 mg/g) and carbohydrate (5.4-17.99 mg/g) in the sediments of the slope region are high. However, the samples from the shelf region gave less values for organic carbon (3.6-4.8 mg/g), total

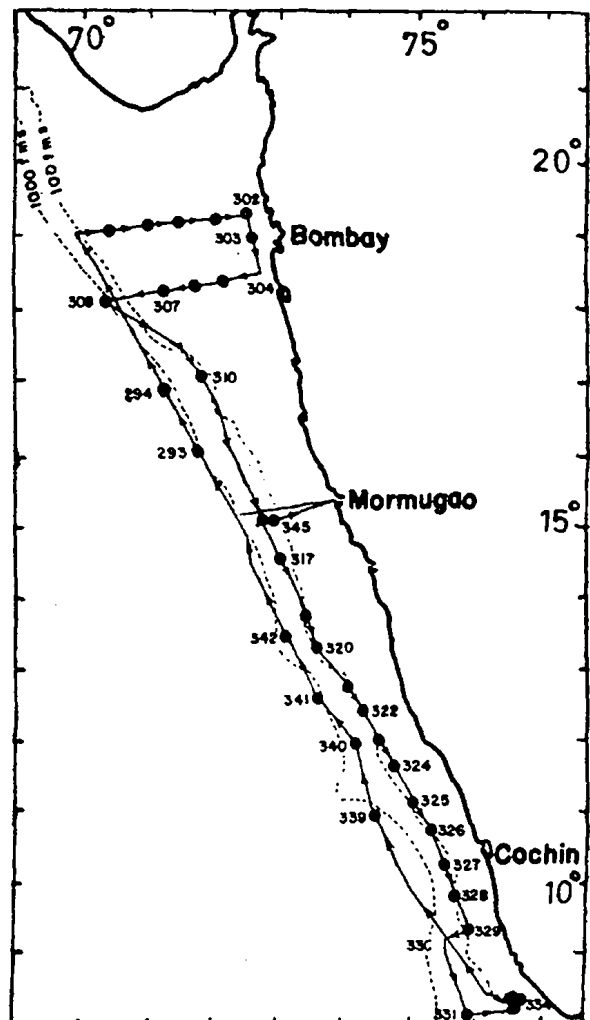


Fig. 1 — Position of stations

TABLE 1 — BIOCHEMICAL COMPOSITION OF ARABIAN SEA SEDIMENTS

(Results are expressed on dry weight basis)

Station No.	Depth (m)	Texture	Organic carbon % air dry sediment	Total nitrogen mg/g	Carbo-hydrate mg/g	C/N ratio	Composition of organic matter		
							Organic matter	Carbo-hydrate% organic matter	Total nitrogen% organic matter
293	1850	Clay	1.32	1.20	5.4	11	2.27	23.78	5.28
298	90	Sand	1.08	0.49	2.66	22.04	1.86	14.3	2.63
299	880	Clayey sand	1.32	0.42	4.33	31.42	2.27	19.07	1.85
300	73	do	1.08	0.98	5.2	11.02	1.86	27.95	5.26
301	49	Clay	1.02	1.06	9.99	9.62	1.75	57.08	6.05
302	17	do	1.14	0.63	10.33	18.09	1.96	52.7	3.21
303	22	do	1.2	0.77	6.25	15.58	2.06	30.34	3.73
305	60	Sandy clay	0.96	0.42	4.5	22.85	1.65	27.27	2.54
306	89	Clayey sand	1.5	0.56	3.2	26.78	2.58	12.4	2.17
307	86	—	1.32	0.91	5.6	14.5	2.27	24.66	4
308	85	Sand	0.42	0.35	1.8	12	0.72	25	4.86
310	320	Sandy clay	4.98	4.24	9.7	11.74	8.58	11.3	4.94
316	280	do	3.3	2.68	8.2	12.31	5.68	14.43	4.71
317	180	do	3.54	2.25	8	15.73	6.1	13.11	3.68
319	85	Clayey sand	1.02	0.91	4.33	11.2	1.75	24.74	5.2
320	70	Sand	0.48	0.63	3.5	7.61	0.82	30.48	7.68
321	98	Clayey sand	1.56	1.76	4.33	8.86	2.68	16.15	6.56
322	87	Sand	1.2	0.32	3.63	37.5	2.06	17.62	1.55
323	110	Clayey sand	1.32	1.4	4.8	9.42	2.27	21.14	6.16
324	83	do	1.14	1.2	3.2	9.5	1.96	16.32	6.12
325	103	—	4.8	4.4	9.99	10.9	8.27	12.08	5.32
326	114	Sandy clay	1.32	1.23	5.33	10.73	2.27	23.48	5.41
327	1000	Clay	6	6.36	17.14	9.43	10.34	16.57	6.15
328	77	Sand	1.08	0.42	3.6	25.71	1.86	19.35	2.25
329	91	do	0.66	0.7	2.99	9.42	1.13	26.46	6.14
331	1340	Clay	5.4	4.6	11.24	11.73	9.3	12.08	4.94
333	60	Sand	0.36	0.56	1.4	6.42	0.62	22.58	9.63
334	45	do	0.42	—	2.53	2.48	0.72	35.14	—
335	40	do	0.48	0.42	1.33	11.42	0.82	16.22	5.12
339	1950	Clay	2.1	2.79	7.99	7.52	3.62	21.82	7.7
340	900	Sandy clay	6.2	6	17.99	10.33	10.68	16.84	5.61
341	1695	Clay	3.1	2.96	11.75	10.47	5.34	22	5.54
342	1370	Sandy clay	3.48	1.62	8	21.43	5.99	13.35	2.7
345	220	Clayey sand	2.82	3.06	7.5	9.21	4.86	15.43	6.26

nitrogen (0.32-4.4 mg/g) and carbohydrate (1.33-10.33 mg/g). Fine grained sediments, in general have high content of organic carbon, total nitrogen and carbohydrate (station Nos. 327, 340). But at few stations (station Nos. 301, 302, 319 and 324), a lower content of these compounds, even in fine grained sediments were noted.

Organic carbon averaged 20.32 mg/g dry weight. These values, however, showed a wide variation, ranging between 3.6 and 62 mg/g. Different factors are responsible for the variations of organic matter in the bottom sediment. While discussing¹¹ the factors responsible for the organic matter variations, it has been pointed out that an abundant supply of organic matter in the overlying water column, a relatively rapid rate of accumulation of fine grained inorganic matter and a low oxygen content favour high organic content in the bottom sediments. Rich organic matter has been recorded in the areas of upwelling¹³. This is further confirmed by the existence of seasonal upwelling in different areas along the west coast of India¹³⁻¹⁶.

Organic production is very high along the west coast of India¹⁷ which naturally explains high organic matter in the bottom sediments. Further, plankton is also often mentioned as the principal material of

organic matter in marine sediments. This suggestion is certainly correct for sediments deposited at shallow depths. However, a small portion of dead plankton settles to the sea floor as a detritus called 'tripton' which is the only material that escapes down to greater depth. Since detritus is an effective absorbant for certain organic molecules, it acts as a carrier for those constituents from surface to bottom of the ocean^{18,19}.

Due to difference in granulometric composition, fractionation of particulate matter could have resulted from differences in settling velocities for particles of various sizes. Organic matter held by fine clay may also be more resistant to biological and chemical modification. Granulometric composition may also have had an effect on the physiological activities of microorganisms in the top layer of sediments. Biological transformation of organic matter begins in the water layer and is influenced by the rate at which suspended particles settle to the bottom. Further, sediment samples near shore may have supported a high population of living organisms than off-shore due to the abundant supply of energy because of less recycling of organic matter in the water column.

Variations in the amount of organic matter at various sites could also have been caused by

differences in environmental conditions for biological activities in the mud surface.

Total nitrogen content in sediment samples varied from 0.32 to 6.36 mg/g (av. 1.76 mg/g). Nitrogen variation followed the same trend as organic carbon. Maximum nitrogen content (6.36 mg/g, station No. 327) was recorded in clay, whereas, sand showed minimum content (0.32 mg/g, station No. 322) which confirms the observation of Trask²⁰ who made the detailed study on the distribution of nitrogen in marine sediments and established a relationship between nitrogen content and particle size.

There is a good correlation between organic carbon and nitrogen. The relationship between these two components has been represented by the least-square regression equation $y = -0.09 + 0.91x$ with a correlation coefficient $r = 0.94$. The relationship is practically linear. It may, therefore, be inferred that the contribution of nitrogen to the composition of organic matter in these sediments is fairly stable.

The unique feature of the data is the irregularity in the levels of carbon and nitrogen with increasing water depth, which confirms the earlier findings²¹. However, the present finding is in contrast with the results reported for sediments from other marine basins where organic matter has been found to decrease uniformly with water depth. Bordovskiy³ found that organic carbon content of sediments from the Bering Sea decreased progressively with water depth and similar results were obtained by others²².

C/N ratio ranged from 2.48 to 37.5 (av. 14; Table 1). As the nitrogen content of organic matter varies in relation to the organism, the ratio of organic carbon to nitrogen in the original matter also varied. The value of C/N ratio is subject to variations in the shelf region in particular and slope region in general, apparently owing to the mixed nature of the organic matter. Increase in C/N ratio has been observed by many investigators^{20, 23, 24}. Klenova²⁵ has reported higher values (29.8-40.1) in the north Caspian sediments and explains it to the supply of highly decomposed plant detritus to sediments. Increase in C/N ratio is also believed to be due to degradation of complex protein and subsequent diffusion of ammonia, nitrate and nitrogen to the overlaying water³. A further explanation of high C/N ratio may be because of high carbonate content in the Arabian Sea sediment²⁶. Lower values of C/N ratio in the sediments are characteristic of samples low in organic matter which can be explained on the basis that the percentage of nitrogen as fixed ammonium will be highest where organic matter has been depleted through biological activity²⁷.

Carbohydrate represents a group of compounds including simple sugars as well as oligo- and polysaccharides. Nevertheless, among the group investigated, it is precisely the carbohydrates which can give the best idea of concentration of readily assimilable organic matter in sediments.

Carbohydrate content in the sediment samples showed large variations ranging from 1.33-17.99 mg/g (av. 6.37 mg/g of air dried sediment).

Maximum content (17.99 mg/g, station No. 340) was noted in sediments found in the middle region of the continental slope whereas minimum (1.33 mg/g, station No. 335) was found in the inner region of the continental shelf. There was a continuous increase in carbohydrate content from the inner region of the continental shelf till it reaches the middle of the slope and a decrease in carbohydrate content at the base of the slope.

There is a direct correlation ($y = 2.14 + 0.208x$; $r = 0.87$) between contents of carbohydrates and organic carbon in the sediment. Similarity in the distribution of organic carbon and the carbohydrate in the bottom sediments supports a genetic tie of the carbohydrate with starting organic materials. Increase in the total content of carbohydrate in transfer from the shelf sediments to continental slope sediments is explained by circumcontinental zonality of the distribution of production of phytoplankton and organic carbon in the Arabian Sea¹⁷. Decrease of the content of carbohydrate in organic matter with increasing depth, observed in continental slope, is associated with intense breakdown of carbohydrate as compared to the decomposition of organic matter as a whole. High content of carbohydrate in sediments may be due to the influence exerted on the composition of organic matter by the bottom fauna which is capable of resynthesis of carbohydrate from non-carbohydrate components of organic matter during the course of their vital activity²⁸.

It can be concluded from the present investigation that sediments varied in their organic matter composition due to the existence of variable conditions along the west coast of India. However, a direct relationship was observed between organic carbon and nitrogen and organic carbon and carbohydrate which is probable evidence of the common source for origin of these components in sediments.

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