st. Oceanogr. & Fish. ARE, 10 (1984) : 99–109

THE DISTRIBUTION OF ORGANIC MATTER IN THE SEDIMENTS OF THE GULF OF SUEZ.

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ABSTRACT

The importance of gaining additional knowledge of the chemistry of the Red Sea bottom sediments is stressed. Methods used for the determinations of organic carbon and nitrogen in 27 samples from the Gulf of Suez are described, and the results of analyses are given. The distribution of organic matter in these sediments is discussed.

The present study indicates that: 1) the organic matter content of the bottom sediments in the Gulf of Suez is relatively small; 2) the C:N is ca. 9.3, on the average; 3) both the organic matter content and the C:N ratio exhibit regional variations, which are ascribed to different environmental conditions in the water column; 4) the mean C:N ratio is shifted a little from the proportions of these elements in mixed marine plankton towards higher values. This was attributed to possible effect of oil contamination of the sediments in the area.

INTRODUCTION

According to Vissar (1972) organic matter includes humic substances, protiens, several amino acids, carbohydrates and pigments.

Organic matter affects the aquatic ecosystem by interacting with inorganic matter to form complex compounds, which include in its structure several other elements. It also serves as a source of food for several animal groups.

The decrease in organic matter after sedimentation is mainly due to decomposition and transformation. Free carbon dioxide and hydrogen sulfide may be released and affect the composition of the sediments even more.

The chemistry of the Red Sea bottom sediments has been studied by several authors (see for ex. Mohamed, 1949; Mohamed, 1980;Beltagy, 1975 and Beltagy, 1984). Mohamed (1980) studied the carbonate distribution in the Gulf sediments, and Nawar (1981) discussed the mineralogy of the same sediments in relation to bottom topography. The mineralogy and texture of sediments collected from the Gulf by R.V. MABAHISS were also dicussed by Shukri (1945) and Said (1951).

The study of organic matter in the sediments of the Gulf has been only dealt with in a cursorly manner by Mohamed (1949). In his work, only 3 samples from the Gulf area were analyzed.

The present paper is thus, aiming at recording the results of the chemical analysis of organic carbon and nitrogen in the sediments of the Gulf and discussing the results in view of the prevailing known environmental conditions.

MATERIAL AND METHODS

Collection and Storage of Samples:

Samples used for the present study, are bottom grab samples collected from the Gulf of Suez during the Soviet-Egyptian Expedition to the Red Sea on board the Soviet R.V. ICHTHYOLOG, during the period 2 to 18 Sep. 1966. Samples were collected along seven sections, 2-3 stations each (Figure 1). The grain size composition and carbonate content of these samples were studied by Mohamed (1980) and the mineralogy was studied by Nawar (1981).

Sub-samples for the geochemical studies were washed chloride-free, dried at 70C°, and kept in a tightly closed glass containers for subsequent chemical analysis.

Five grams of each sample were ground in an agate mortar to pass 200 mesh size sieve . Aliquots of these powder were weighed out for carbon and nitrogen determinations.

Methods of Chemical Analysis

1- Organic Carbon Determination:

The content of organic carbon was determined by wet combustion method as described by Allison (1935). Ten ml. of potassium dichromate was evaporated in a large Pyrex test tube; after dryness, 0.500 gm of the dried sample was added, followed by 10 ml of concentrated sulfuric acid. The contents were heated to 175 C° for 90 seconds. The mixure was cooled and poured quantitatively into 50 ml distilled water. The solution was then diluted to 150 ml. Five gms of sodium fluoride were added and the mixure was titrated against standard ferrous ammonium sulfate solution. Organic carbon was calculated as percent of the total dry sample.

2 - Organic Nitrogen:

The organic nitrogen content was determined by the micro Kjeldahle

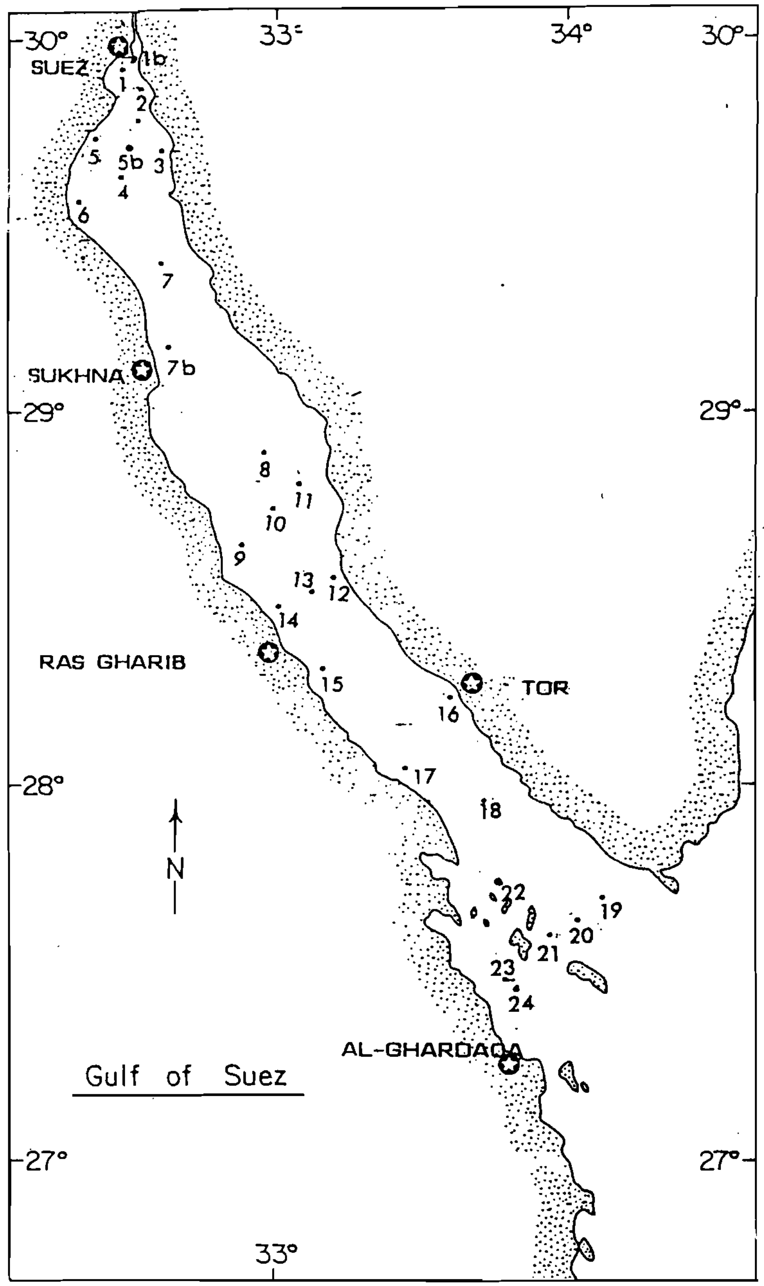

Fig. 1. Location of sampling stations.

method. Ammonia produced from the digestion of the sediments was measured colourimetrically using the method described by Strickland and Parsons (1969). Nitrogen was calculated as percent of the total dry sample.

RESULTS

The results of the analyses are tabulated in Table 1.

TABLE 1
Organic Carbon and Nitrogen content, and the C:N Ratio in the Sediments of the Gulf of Suez

Serial No.	Sample No.	Type of* sediment	Organic C%	Organic N %	C/N Ratio	Mean grain size*
1	239(b)	-	0:551	0.112	4.9	-
1(b)	239(r)		0.486	0:052	9.4	-
2	233	silty sand	0.995	0.067	14.9	-
3	234	silt	0.409	0.097	4.2	-
4	44		0.615	0.064	9.6	-
4(b)	235	silty sand	0.652	0.077	8.5	-
5	236	silty sand	0.575	0.089	6.5	-
6	229	sand	0.391	0.045	8.7	-
7	198		0.929	0.025	37.1	-
7(b)	238	silt	0.474	0.021	22.5	-
8	220	sand	0.242	0.063	3.8	1.98
9	221	silty sand	0.922	0.072	12.8	5.00
10	222	silty sand	0.774	0.074	10.5	4.83
11	223	silty sand	0.855	0.092	9.3	4.23
12	217	sand	0.438	0.135	3.2	2.03
13	218	sand	0.384	0.050	7.7	1.55
14	219	sand	0.195	0.039	5.0	1.98
15	205	silty sand	0.492	0.076	6.5	3.53
16	209	sand	0.273	0.067	4.1	1.23
17	204	sand	0.465	0.083	5.6	2.98
18	216	silt	1.016	0.032	31.8+	5.58
19	215	silty sand	0.586	0.073	8.0	3.35
20	213	sand	0.458	0.090	5.1	1.90
21	210	sand	0.287	0.067	4.4	2.67
22	214		0.335	0.064	5.2	-
23	Q(r)		1.941	0.017	114.0+	-
24	Q(r)		0.626	0.020	31.3+	-
Average			0.552	0.069	9.3	

* = After Mohamed (1980).
\+ = are excluded when calculating the average.

The 27 samples examined are distributed as follows: 1) five samples were obtained from Ataqa-Northern Galala sub-basin, 2) ten samples were obtained from Wadi Araba sub-basin, 3) six samples were obtained from Southern Galala sub-basin, and 4) six samples were collected from Al-Mallaha sub-basin.

DISCUSSION

Due to the prevailing semiarid conditions, the Gulf of Suez receives very little fresh water that drains the flanking barren mountains and hills. Thus, the main source of organic matter is most likely to be the debris of plants and animals inhabiting its waters and living on its bottom.

Organic matter undergoes relatively rapid transformations during sedimentation and early diagenesis. However, still in an area like the Gulf of Suez, it will reflect the intensity of these transformations and also reflects the availability of nutrition for bottom dewelling organisms.

In fact, several factors control the organic content of any marine sediment . These factors are: 1) the rate of supply of organic matter; 2) transportation by currents; 3) rate of sedimentation; 4) sea bottom topography;and 5) texture of the sediment.

In general, the sediments of the Gulf of Suez have an organic carbon content ranging from 0.195% to 1.941%, with an average of 0.552%. The organic carbon in the sediments of the Gulf of Suez shows a distinct zonal pattern. In the northern part, just south of Suez Bay, sediments had high carbon contents that ranged from 0.5% to 1.0%. This is followed to the south by a relatively poor zone, with organic carbon content of less than 0.5%, this is followed again by a rich zone, midway between Abu Zeneima and Ras Gharib. The area south of that region contained organic carbon of less than 0.5%. This latter zone extends little south of Tor (Figure 2). The entrance of the Gulf has a high organic carbon content, except the near shore area of Al-Ghardaqa approaches.

This type of zonal distribution may be explained if we look at the prevailing oceanographic conditions in the area. The first zone, off the Suez Bay is, to a large extent, under the influence of the water discharged from the relatively shallow small bay. The bay receives the refuse of the city of Suez, besides the wastes of the paper mill and fertilizers and cement factories in the nearby areas. Anchorage of the caravans crossing the Suez canal lies in the entrance of the Bay, also adds organic material to the area. The organic matter finds its way to sediments at the entrance of the Bay, due to changes in current velocity, resulting in the observed enrichment of sediments with organic matter. It is worth to note here that the organic carbon content in the sediments of the Bay itself is not that high(0.6); which may be related to the rate of flushing

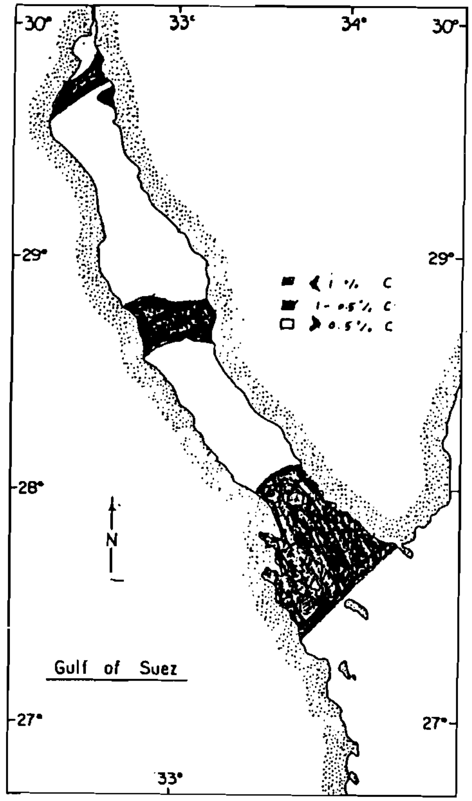

Fig. 2. Area distribution of organic C.

of the Bay, or due to much slower rate of sedimentation as a result of active stirring by passing-by ships. It is also worth noting that the oil pollution from refineries and terminals did not affect the organic carbon content to any extent. This is evidenced by the low C:N ratio reported for samples collected from this area (Table 1). The low C:N ratio implies that organic matter is of nitrogen rich type, which is certainly not petroleum hydrocarbons.

The second organic rich zone, lies, almost, exactely in an area where satellite photographs indicate a large gyre with a distinct temperature pattern that is lower than surrounding areas. This large gyre will certainly result in a high primary productivity, which in turn ensures a high rate of supply of organic matter to the sediments in that area. The biogenic origin of the organic matter in this area is evidenced by its higher nitrogen content, and thus lower C:N ratio, which is close to that of mixed plankton.

This ratio becomes even closer in samples collected from the eastern side of this area.

The third zone, which lies at the entrance of the Gulf of Suez, also has a rich supply of organic debris. Here, the organic productivity is considerably high as a result of water mixing and semi-upwelling conditions, that extends further south covering the area of possible turbulence due to sudden change of water depth between the Red Sea proper and the Gulf (El-Sabh and Beltagy, 1983).

The organic carbon content shows a very strong +ve. correlation with grain size (c.c 0.91). Fine sdiments contained higher organic carbon than coarser ones. This is in agreement with what appears in the literature for other sediments from different environments (see for ex. Beltagy. 1973). This stronge +ve. correlation reflects the effect of aeration in the sedimentary column; coarse sediments usually have larger pores, thus faster circulation and movement of interstitial water and oxygen -rich sea water.

The organic nitrogen content of the Gulf sediments ranges from 0.017% to 1.135% with an average of 0.069%. It also exhibits a dominant zonal distributional pattern similar to that of organic carbon (Figure 3). This pattern is particularly evident in sub-basin 1, and in the middle portion of the Gulf and it is certainly related to primary productivity.

In the first zone, organic productivity is enhanced by human-induced fertilization due to waste disposal, and also by the relative shallowness of the area, permitting photosynthesis to take place throughout the whole water column.

In the second zone, high productivity is maintained by upwelling induced by gyres forming in this area, particularly on the eastern side. It also coincides with a nutrient rich zone as shown by El-Sabh and Beltagy (1983).

The area at the entrance of the Gulf still maintains a high nitrogen content.

However, the association between organic carbon and nitrogen seems to be lacking in the Gulf of Suez. Correlation is insignificant. The areal distribution of C:N ratios (Figure 4), indicates that the source of organic matter is indigenous to the Gulf, and mainly related to the areas of high organic production. It is likely then, that such areas will show swarming of benthic fauna and demersal fishes.

Areas with relatively low C and N are mostly areas of low productivity in the water column. The organic matter in their sediments is mainly transported by currents from other nearby areas. Decomposition of organic

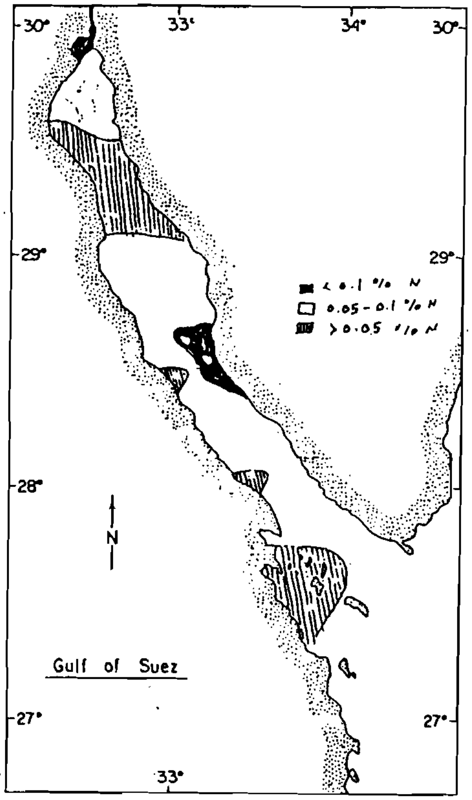

Fig. 3. Area distribution of organic N.

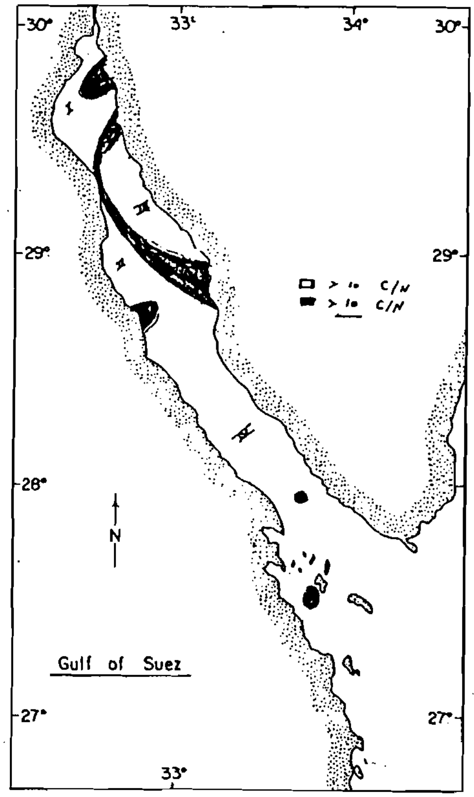

Fig. 4. Area distribution of C/N ratic.

matter involves oxidation of organic carbon and disappearance of nitrogenous compounds which are likely to be attacked by bacteria. Thus, these areas could be the real factory where regeneration of nutrients takes place. Nutrients will be later transported to the north and south of these areas. This is evidenced by the location of such poor zones between two richer zones in every case; and also the high phosphorus content in the water column of these areas compared with other regions of the Gulf (El-Sabh and Beltagy, 1983).

However, compared with other regions (Table 2), the Gulf is relatively poor in organic matter content of the sediments. The C:N ratio in the Gulf is on the average 9.3, with a very high satndard deviation (8.7), as it ranges between 37 and 3.

Mohamed (1949) had examined 3 samples from the Gulf and he gave an average of 8.2. Excluding sample No.7, the ratio in our samples is imporved to 6.82 ± 3.2. This ratio is very close to that reported by Mohamed (1949) for the sediments from the Gulf of Suez. It is close to ratios reported from other marginal seas (Table 2). It is also very close to the ratio reported for mixed marine plankton (Redfield et al., 1963). This may support the idea that the organic matter in the sediments of the Gulf is mainly derived from marine organisms.

TABLE 2
Organic C, Organic N and C/N Ratio in the Sediments
of the Gulf of Suez, Compared with other Areas and Organisms.

Area	Organic C%	C/N Ratio	Author
Baltic Sea		10.00	
Arabian Sea	14.40	8.90	Chester and Stoner (1974)
Black Sea		5.70	
Red Sea		5.20	Mohamed (1949)
Gulf of St. Lawrence	1.69	56.00	Beltagy (1973)
Deep Sea Sediments	0.50	21.00	El-Wakeel and Riley (1961)
N Atlantic Shelf Sediments	3.63		Rashid and King (1969)
Caspian Sea		35.00	Bordovisky (1965)
Gulf of Suez	0.39	7.70	Mohamed (1949)
Gulf of Suez	0.55	9.30	Present work
Marine Organisms		6.25	Redfield et al. (1963)

If we look to the location of the excluded samples, we find that sample No.7 is next to the eastern coast near the end of the journey of the Red Sea waters, perhaps, the area is an area of convergence. The same can be said about the stations in the far south near the entrance of the Gulf. However, these areas might had been affected by oil pollution that raised the carbon content without corresponding increase in the nitrogen content. Otherwise, the C:N ratio of the sediments are close to the open regions of the Red Sea.

CONCLUSION

The present investigation indicates that the organic matter content of the bottom sediments in the Gulf of Suez is relatively small. The organic carbon content is related to the texure of the sediment, being higher in fine sediments. The C:N ratio exhibits a regional distribution pattern, which is related to the prevailing environmental conditions. The ratio is shifted a little from the proportions of these elements in mixed marine plankton towards higher values. This was attributed to possible effect of oil contamination of the sediments in the area.

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