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GULF OF SUEZ REVISITED: TEXTURE AND ORGANIC CARBON CONTENTS OF SEDIMENTS, RED SEA, EGYPT

KHADR, A* AND SAKR, E **

**Oceanography Department, Faculty of Science, Alexandria University*
***Arab Academy for Science and Technology and Maritime Transport*
E-mail: AhmedKhadr@yahoo.com

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ABSTRACT

The Gulf of Suez is one of the main waterways in Egypt which greatly supports numerous industries that affects the Egyptian economy. The area has witnessed a development in industrial(such as oil and gas exploitation) and urban activities. Oil and gas industries are the largest in the Gulf and the neighborhood ports as well as tourism. The bottom sediments of the Gulf of Suez are covered mainly by sand fraction primarily of Biogenic origin. Finer clastic materials was brought into the Gulf by Wadi systems. The sediments are characterized by relatively low organic carbon contents. The area of high organic carbon content are situated near the places where Wadi mouths drained.

1. INTRODUCTION

Gulf of Suez has gently sloping broad coastal plains and its submarine slopes are symmetrically gentle, reaching a maximum depth of 50 - 70 m. Because of the gentle slope, both periodic sea level changes, tidal and seasonal changes (~ 1.5 m) are affecting large areas along of the Gulf (Friedman & Krumbein, 1985). Large intertidal areas exist where sand waves are associated with cuspate spites. The cuspate spit complexes provide the settings for lagoons which are seasonally flooded in winter, only to be exposed as sabkhas in summer during the lowest sea level. Some sea-marginal environments differ between southern and northern parts of the Gulf. A distinctive aspect of sedimentation is observed; reefs not only survive but, in fact, thrive in close juxtaposition from the transport and deposition of copious amounts of Terrigenous sediment. The reefs even protect the sedimentary fans along their tidal margins. Thus, despite the tendency for the waves to destroy a fan, it persists due to the protection of the reef (Friedman & Sanders, 1978).

Morphologically, the Red Sea has continental shelves to the east and west, a wide central depression extending from Lat. 15° N to the tip of Sinai at Lat. 28° N, and a narrow, clearly marked axial valley between the 600 m and 1500 m bathymetric contours from 15° N to 24° N (Drake & Girdle, 1964, *c.f.* El Sayed, 1990). After the digging of the Suez Canal, it became an international water passage for navigation. The major constituents of the Red Sea sediments are Biogenic constituents (Nannofossils, foraminifera, pteropods, siliceous fossils). Volcanogenic constituents include (Tuffites, volcanic ash, montmorillonite, zeolite). Terrigenous constituents involve (Quartz, feldspar, mica, heavy metals), authigenic minerals (aragonite, dolomite, chalcedony). Evaporate minerals in the form of (Magnesite, gypsum, halite), Brine minerals (goethite, hematite, pyrite, and anhydrite) (El Sayed, 1990). Apart from the above-mentioned constituents of the Red Sea sediments, reefal sediments and sea-marginal lagoon sediments are the most characteristic deposits in the nearshore area. All along the present shoreline there are recent coral reef deposits of limestone, some of which are as much as 300 m thick (El Sayed, 1984). Gulf of Suez is a nearly closed arm of the Red Sea. It extends for about 50 km at its widest point. It connects with the Mediterranean Sea through the Suez Canal and with the Red Sea through the straight of Jubal. It is an arid zone with minor amount of fresh water influx from the surrounding Wadi systems (Mohamed, 1992).

No rivers outflow into the Gulf. Water and salt budgets are dominated by the fact that loss of water from the system by evaporation exceeds the gain from precipitation and runoff combined (Morcos, 1970). The Gulf constitutes a linear zone of subsidence. It represents a taphrogeosyncline (Said, 1969). Heybroek (1965) stated that sediments of about 5 km thick overlie the Precambrian basement, 2 km of which are of Tertiary age. The present form of the Gulf was attained sometimes during the Oligocene, when the modern was formed (Said, 1969). The Gulf fault trough is about 80 km wide becoming narrower towards the north. One third to one half of this fault is covered by shallow water (Girdler, 1969). A marine gravity survey revealed a negative gravity anomaly of approximately –50 gal. Indicating an infill of light sediments (Masson & Agnich, 1958). The magnetic field (Coleman, 1974) is relatively smooth, reflecting the lack of igneous activity and suggesting that the sediments are underlain by down faulted Pre-Cambrian Shield rocks. Rifting in the Gulf is very recent and appears to have begun sometime in Pliocene.

In the last decades, there are several oil fields with numerous platforms, well heads and flares in the central and southern part of the Gulf. There are also pipelines, sometimes not buried or charted (Sakr, 2003). As a result of the above, there is a need for updating the information. The aim of this study is to provide a texture descry iption of the bottom sediment and its relation to the organic carbon content in order to trace any future anthropological source in this area.

2. MATERIAL & METHODS

Thirty samples were collected from the bottom of the Gulf (12 from theeastern flank and 18 from the western flank) and were taken using grab sampler from localities fixed by GPS, to represent nearly all different basins of depositional sediments, Fig. 1. Sampling periods were from May 1999 to May 2001. Polyethylene marked bags were used for storage. Each sample was divided into two sub-samples; the first was left to be air-dried for further analysis, while the second was stored in deep freezer at -4°C. The first sub-sample was then disaggregated by rubbing with fingers and splitted by the cone and quarter technique. After splitting, 25 grams were subjected to grain size analysis by sieving the coarse fraction (more than 4 Φ). In fact, representative sub-samples were divided through a standard set of sieves “Geyer type” mounted on an electric shaker machine (Labor-Technique-Ilmenau). The standard time of sieving applied was 15 min. The sieves were arranged in a 1Φ interval. The graphic measures given by Folk& Ward (1975) were employed for the results of the grain size analysis using the Φ notation. The nomenclature of the samples used for Arial distribution is based on the triangular diagram described by Folk (1965). The determination of organic carbon content of the samples was done according to the method described by El-Wakeel & Riley (1957).

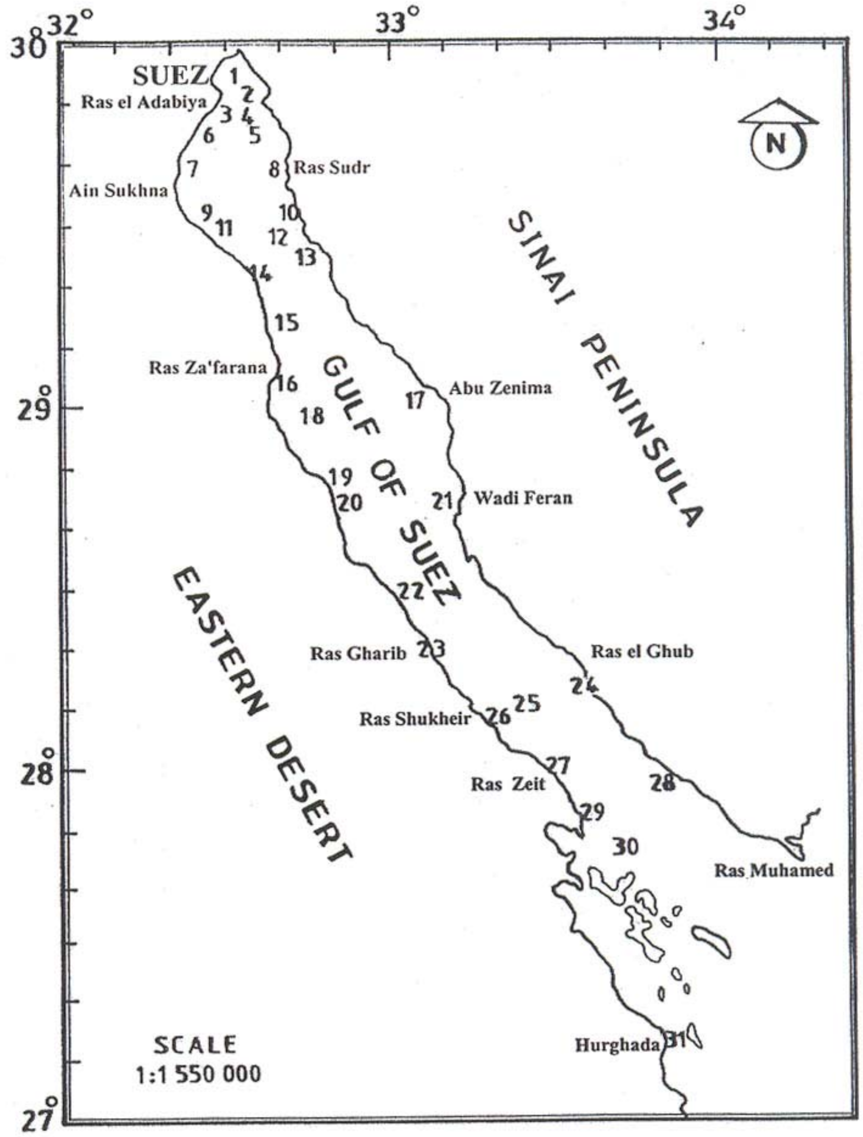

Fig. (1): Bottom sediments sampling stations.

3. RESULTS & DISCUSSION

The texture of the surface sediments of the Gulf of Suez is ranging from very coarse to fine sand, Fig. 2, Table 1. There are only some exceptions of fine sediments expressed as fine silt .First in the north and extended to station 10, is characterized by a uniform medium to fine sand size. The southern group of samples is mostly characterized by a very poorly sorted coarse sand. It includes also scattered silt fraction. These findings show no difference, when compared with the study made by Mohamed (1991). He stated that the very coarse sand is present in the southern part of the Gulf. Generally, the eastern part have coarser sand than the western side. Silt forms four distinct patches on the bottom related to the mouths of the Wadies. The area of the greatest influx of silt appears to be in the middle of the Gulf. Figs. 4a & 4b represent the interrelations between the mean grain size, the graphic standard deviation (sorting), and the skewness, respectively. A slight correlation is observed; sorting decreases with the decrease in grain size. However, there is no correlation between the mean size and the skewness. From the foregoing discussion, it can be concluded that there are two main factors which could play a major role in influencing the sediment distribution. The first is the abundance of coral reefs and the second is the presence of Wadies draining which surrounding areas and passing into the Gulf. Furthermore, Sukri & Higazy (1944) stated also that the Gulf of Suez because of its flat bottom has deposits with but little variation in their statistical data. The sediments of the Gulf though of shallow origin are, in fact, comparable with those given by other normally sorted continental shelves; the Gulf is itself a shallow flat shelf filled with the surface water of the Red Sea and descending at its mouth abruptly to a depth five times greater than its own. Though these results are of value in the reconstruction of paleogeographic conditions of deposition for ancient sediments. Nawar (1983) has studied the bottom sediments and the topography of the Gulf, and found that the Gulf receives its bottom clastic sediments through a number of Wadies that drain different types of source rocks. Also, the study of mineralogical composition showed that the light fraction does not give any difference along the Gulf. The heavy mineral fraction constitute four provinces. To each, is attributed a certain type of source rocks which seems to be the first factor controlling the variation. Topography is the second factor. Moreover, Mansour *et al.* (1983) reported that the mean size lies between 2 and 3 Φ (fine sand). Generally, from the land toward the sea, the mean diameter decreases. This variation is may be due to one or more of the following reasons. The first, after deposition, longshore current may transported them toward the north, leading to the fineness of grain size and improvement of sorting in that direction. Second, the sediments of the north part may have been affected by longer transportation than the southern valleys because these are larger and longer. Generally, samples on the western side of the Gulf are characterized by coarser sediments than the eastern one.

On the other hand, the total organic carbon content is also showing the same trend of distribution, Fig. 3 and Table 1. The northern part is characterized by a uniform distribution, which has relatively low values, except in station 7, which has a value of 2.34%. The southern group of samples, has also a higher values of organic carbon. This can be reflected by the highest value in station 26, which is 3.12%. The relatively lower values of organic carbon can be attributed to the position of this area further away from the reverine input or terrestrial discharge which is regarded as the main contributor of the organic detritus, or the effect of waves and longshore current which may remove the fine particles and the associated organic carbon. These results could be attributed to the nature of the samples themselves. Such findings coincide with that cited in the report of UNESCO, 1976, which suggested that the input of organic carbon is not only by settling, but also through incorporation of organisms. In addition, Mohamed & Shamlan (1979) proved the same results. They attributed the low values to the texture of the sediments, wind generated currents and the organic materials drained from land trough Wadi system. In addition temperature changes act as accelerating or decelerating factors of the degradation of organic matter (Gerringa, 1990).

Table (1): Grain size and total organic carbon contents

Stations	Grain size	Total organic carbon %
1	Fine sand	0.82
2	Fine sand	0.41
3	Fine sand	1.25
4	Medium sand	0.35
5	Medium sand	0.92
6	Medium sand	0.52
7	Medium sand	2.43
8	Medium sand	0.49
9	Fine sand	0.53
10	Very fine sand	0.90
11	Coarse sand	1.25
12	Coarse sand	0.59
13	Coarse sand	0.85
14	Coarse sand	0.82
15	Fine sand	0.85
16	Coarse sand	0.95
17	Coarse sand	0.89
18	Coarse sand	0.29
19	Medium silt	0.15
20	Coarse sand	0.20
21	Coarse sand	0.85
22	Medium sand	0.22
23	Coarse Silt	0.1
24	Coarse sand	0.46
25	Coarse sand	0.15
26	Coarse sand	3.12
27	Very fine sand	0.76
28	Medium sand	0.19
29	Coarse sand	0.48
30	Medium sand	0.26

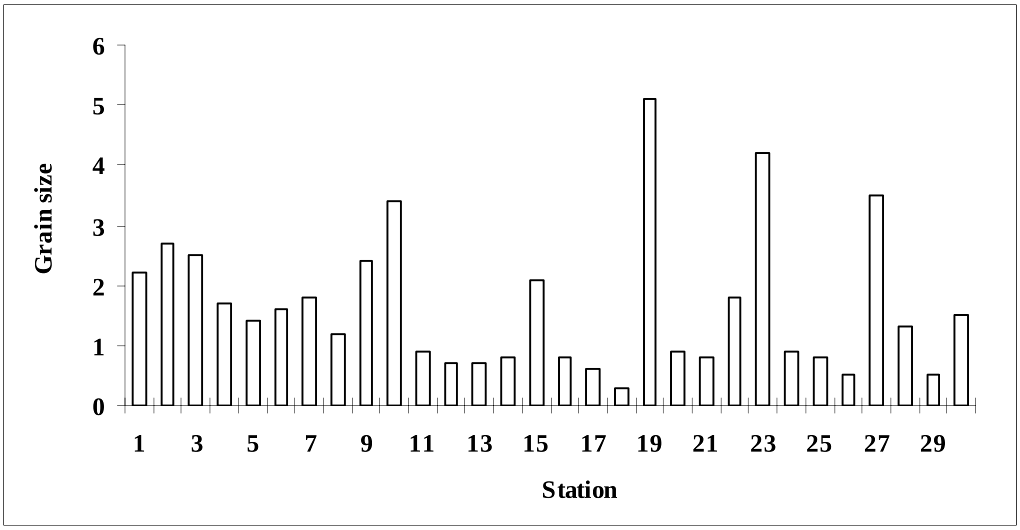

Fig. (2): Sediment texture histogram

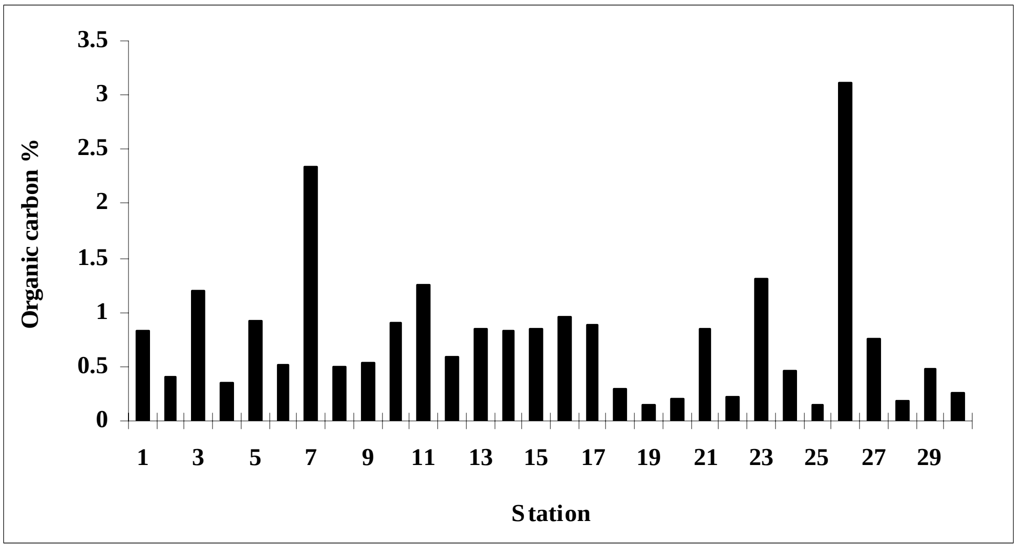

Fig. (3): Sediment organic carbon content histogram.

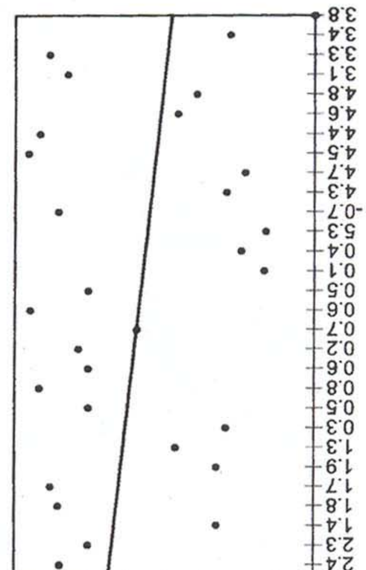

Fig. (4 a): Correlation between mean size and Sorting.

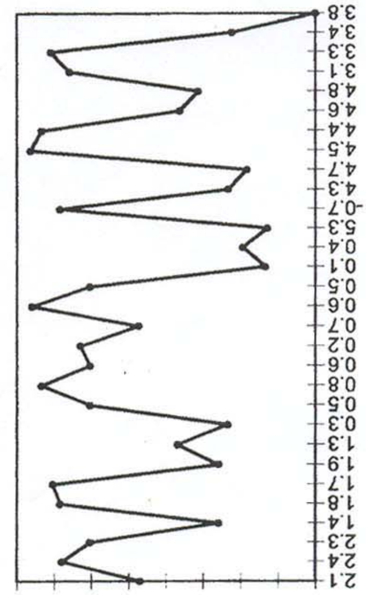

Fig. (4 b): correlation between mean size and skweness.

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