1.4. The Yachts and Fishermen Marina

The marina is located in Sakkala area, about 5km south Hurghada at 27° 13′ 35″ N and 33° 50′ 28″E. This site was for fishermen boats and the contamination was massive. Plastic bottles, wood remains, sinking old boats, rubbish, cans and oil are the main wastes in the area. The fill operation has used sediments transported from the land outside the site and close to the mountain area (Fig. 4A,B & C). The total land filling is about 732328.2 m^2 and dredging is about 43226.18 m^2 (Fig. 3c). Coastline alteration by dredging and landfilling operations of shallow water areas and the excavating artificial lagoons are the main environmental problems causing massive destruction of the marine life in the area.

1.5. The Oil Exploration and production Site

The site is located in the northern limits of Hurghada. about 35 km north of the City at 27° 28′ 27″ N and 33° 37′ 31″ E. The area is used for oil exploration and production. Two landfilled tongues connected with two landfilled islands (Platforms) have been constructed in the intertidal zone for drilling oil wells and connecting pipelines. The total land filling in the area is about 88013.108 m^2 (Fig. 3d). There was a huge impact on marine environment during fill operations and drilling the oil wells (8-12 wells). Wastes of drilling are distributed at the southern side of the landfilled platforms. Unfortunately, most of the released sediments during construction were washed into the sea. Nevertheless, a huge amount of dust was blown offshore. The original coastline has been completely altered by filling operations (Fig. 4D,E & F). During drill operations of the oil wells some crude oil was flown out beside the two platforms and tongues.

2. MATERIALS AND METHODS

One hundred and nine samples were collected in 2002 (12 samples from the beach and 97 samples from the intertidal zone), until the breaker zone at coral reef crest, in front of the different four development projects. The samples were taken by pushing a plastic box about 10 cm deep into the sediment. Oceanographic parameters that control the coastal features of the Red Sea, such as salinity, temperature, pH and turbidity values were determined during samples collection. Moreover, most of these parameters, especially water temperature (Temp), pH, salinity (S), total dissolved salts (TDS), specific conductivity (Spec) (ms/cm is the selected unit from the unit list of the used instrument), dissolved oxygen (DO), and oxidation reduction potential (Eh) were measured in the summer 2002 (July-August) at different studied localities in the area by using hydrolab surveyor-4 model instruments of Inst. Oceanography and Fisheries, Hurghada (Table 1).

The grain-size distribution of desalted sediments was determined by wet sieving of sand and gravel and by pipette technique for silt and clay fractions (Folk, 1974). The analyses were carried out in Inst. Oceanography and Fisheries, Hurghada. All chemical analyses were carried out in duplicates and the average data was determined. The total organic matter content of all samples was determined by Allison method (1935) that depends on the back titration. The organic carbon content determined as follows: Total organic matter = organic carbon x 1.8. Carbonate content was determined by treating the samples with HCl acid. The insoluble residue was separated and the carbonate % was calculated. Concentrations of 13 major and trace elements (Fe, Mg, Ca, Na, Cd, Mn, Co, Cu, Ni, Pb, Sr, and Zn) were determined using a computerized flame Atomic Absorption Spectrophotometer (Varian model) of Inst.

Table (1): Oceanographic parameters measured during summer 2002 at the studied localities.

Station	DO (mg/l)	S%	pH	Eh(MV)	Temp.	TDS (g/l)	Spec (ms/cm)
Abu Shaar	5.31	40.52	8.61	351	30.3	38.3	59.56
Hurghada Area	5.44	40.3	8.65	333	27.8	38.1	59.69
Marine station	5.55	40.47	8.61	355	27.5	38.32	59.87

Oceanography and Fisheries, Hurghada. Samples collected from areas away from any expected contaminants were used as reference material for trace metals (Mansour, *et al*., 2000).

Multivariate analysis (correlation and cluster analyses) of data was carried out to determine associations among elements, and to objectively find groupings of similar samples along the coast. Analyses are carried out on the data using the computer programs of the SPSS.

3. CLIMATE AND OCEANOGRAPHIC INFLUENCES

Generally, in the northern Red Sea Coast, the prevailing wind is mainly NNW all the year round (Morcos, 1970). The average air temperatures at Hurghada are fluctuated around 17.38°C in winter and vary between 27.5 and 30.6°C in summer (the Egyptian Meteorological Authority Reports). Humidity depends on the activity of the wind region over this area. At night landward winds tend to be dry but lower temperature raise the relative humidity, also in summer ES wind over saturated with water occasionally bellows over the Red Sea.

A close relationship is observed between air and sea surface temperatures. Water temperature clearly reflects seasonal changes (summer: 28-29°C, winter: 21-23°C). In extreme shallow areas higher values were measured due to solar radiation (Piller and Pervesler, 1989).

Water temperature varies from 27.5°C to 30.3°C, salinity (S) from 40.3‰ to 40.52‰, pH values between 8.61 and 8.65, dissolved oxygen (DO) from 5.31 to 5.55mg/L, total dissolved salts (TDS) from 38.1 to 38.32 g/L, oxidation reduction potential (Eh) between 333 and 335mv, and specific conductivity (Spec) from 59.56 to 59.87ms/cm. The water salinity is relatively high in semiclosed areas as bays and valley mouth (up to 44.5 ‰ in July; Piller and Pervesler, 1989). The tide is semidiurnal, max. peak every 12 h with a mean tidal range of ab. 0.80 m.

4. GRAIN SIZE DISTRIBUTION

The present study deals with grain size characteristic of the beach and intertidal sediments in order to shed some light on the physical properties, real distribution and the depositional environment. The grain size were done initially on siliceous clastic sediments, but in the last few years, it has been used for carbonate rocks (Flügel, 1982), and mixed carbonate-non carbonate sediments (Mansour, 1989; Piller and Mansour, 1990; Mansour, 1995; Mohamed, 2000; Madkour, 2004). Some authors are of the opinion that the reliability of grain size parameters of carbonate sediments for estimating depositional conditions may be questioned seriously, because the unequal hydrodynamic behavior of skeletal particles having extremely diverse morphology and because much carbonate sediments either remain in place or has undergone little transportation (Jindrich,1969). Other workers have determined these parameters and successfully related with the environment of deposition (Lewis, 1969; Taylor and Lewis, 1970).

Although most of the collected sediments are biogenic, beach and near shore samples contain high amounts of clastic sediments highly influenced by geological and sedimentation factors. Therefore, the grain size analysis is important and gives a good idea about the particles size and characteristics of sediments.

Cluster analysis (using Ward's method) includes gravel, sand and mud separating all samples (109) into 3 main clusters (Fig. 5). The first cluster represents 30.27% (33 samples) of the total samples and is characterized by the abundance of sand (73.31%) and gravel (25.12%) with low mud (1.57%). The second cluster represents 29.36 % (32 samples) of the total samples and is characterized by the abundance of sand (98.1%) with very low mud (1.23%) and gravel (0.67%). The third cluster represents 40.37% (44 samples) of the total samples and is characterized by high sand (91%), highest mud content (5.92%) and low gravel (3.08%) compared to the other clusters. The reason for this high mud content of cluster 3 is the landfill and dredging.

Distribution of gravel, sand and mud fractions is related to the type of source sediment, water depth and the distance from the shore. The result indicated that the predominant sediments are the coarse sands, with some exceptions at the second tourist site and the oil exploration site where the mud content is up to 17.05% and 12.24%, respectively (Tables 2,3). The main reason for this high mud content is the landfill in these sites. From the beach to about few hundred meters seaward fine sands and mud dominate most areas, whereas medium to coarse sands occur in the beach and close to the dredging areas. In some areas fine sand and mud dominate the dredging areas. This distribution of coarser sediment may reflect the abundance of terrigenous sediments at the beach, and carbonates around the dredging areas. The distribution of carbonates supports this result where carbonate content is low at the beach and gradually or abruptly increases seaward (Fig. 2). During dredging the winnowed material are transported in the nearshore zone and leave the coarser materials behind. The gravel fraction reaches to the highest percentage in the sediments of the first tourist site (from 0 to 32.29%) and the centeral Marina (from 0.00 to 42.89%) due to the abundance of materials transported from the excavation in these areas. Sand is the dominant fraction in the sediments of the study areas.

The distribution of mean grain size (Mz) depends mainly on the type of sediments and the water depth. Therefore, the increase of mean grain size is associated either with the higher carbonate content or with the effect of dredged or landfill processes. The investigated sediments of different environments range from very fine skewness to very coarse skewness and from very platykurtic to very leptokurtic category. This variation in character of sediments is produced in one side by diversity of skeletal grains and the effectiveness of currents and wave actions and in other side by types of flux of clastic sediments. Duane (1964) recorded that negative skewness is produced by winnowing action along the beach and tidal inlets, where erosion or non deposition and high energy conditions prevail, while positive skewness is found in sheltered areas where fine materials may accumulate. He attributed a mixture of positively and negatively skewed curves to type of flux of clastic sediments. Similar kurtosis values were obtained by El-Sayed and Hosny (1980) for sediments of the intertidal zone in the area surrounding the National Institute of Oceanography and Fisheries at Hurghada. Folk and Ward (1957) recorded the high and low values of kurtosis to a mixed population. They also suggested that if the environment of final deposition is not effective in sorting, the kurtosis will remain high and the opposite occur if the environment is effective. Nordstrom (1977) has related the variations observed in different areas due to the difference in the mode of wave energy causing variations in redistribution of the sediments. Moreover, there are two main sources of sediments supply biogenic fragments from the sea and terrigenous influx from the hinterland and mountains. Folk and Robles (1964) and Pilkey *et al*., (1967) showed that the carbonate beach sands tend to be leptokurtic or excessively peaked. Generally, the values of all size parameters of the sediments in different areas vary from one sample to another and there is no tendency for general increase or decrease along each area or from south to north reflecting the variations in the nature of the area, the source of the sediments and the water depth.

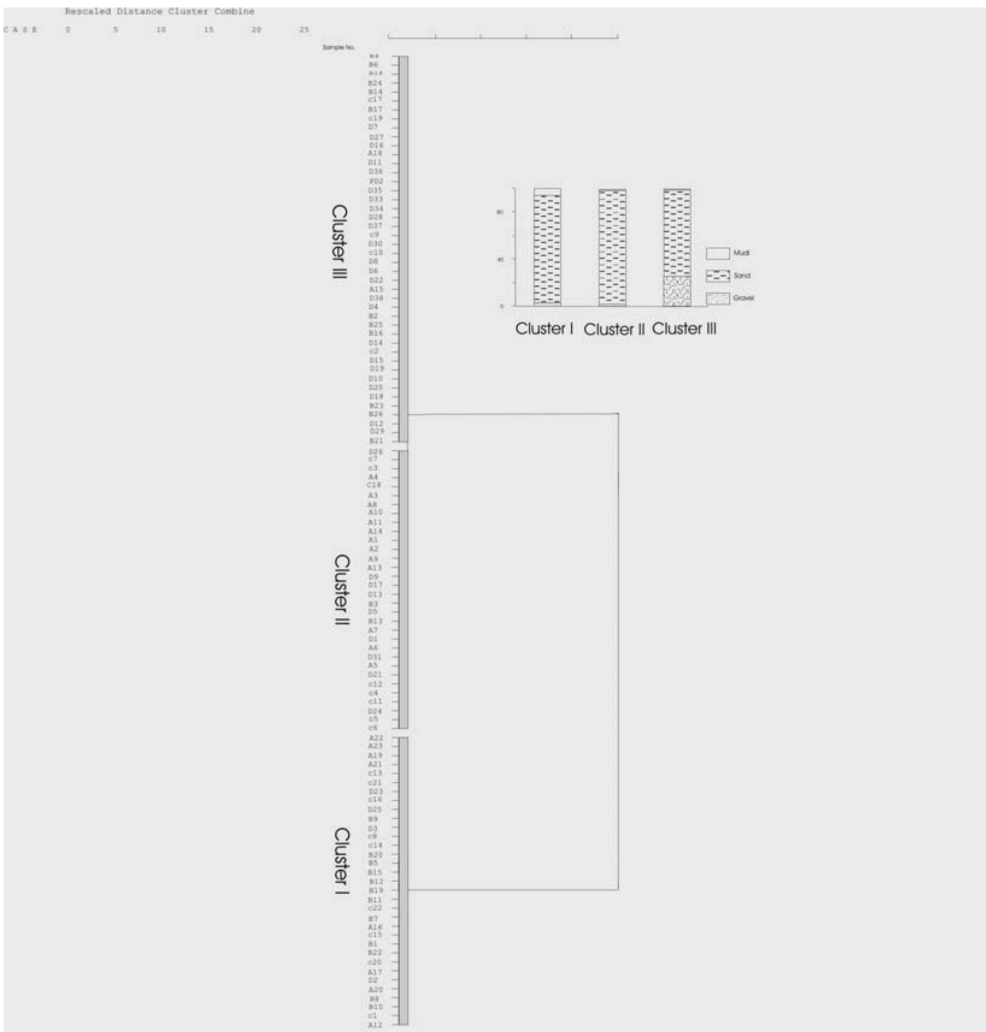

Fig. (5). Dendrogram from cluster analysis (Ward,s method) and histogram exhibiting cluster of grain sizetexture.

Table (2): Grain size parameters and textures of sediments of selected studied sites.

Site	Desert Rose site.			Master Line site			Hurghada Marine site			Magwish Company site.		
Parameter	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Gravel %	0.00	32.29	8.59	0.02	48.76	15.91	0.00	42.89	10.35	0.03	23.68	3.87
Sand %	66.43	99.92	90.24	0.02	50.40	80.61	56.59	99.27	87.29	70.24	99.73	91.32
Mud %	0.02	6.86	1.17	0.08	17.05	3.47	0.29	6.52	2.36	0.22	12.24	4.81
MZ (φ)	-0.17	3.32	2.01	-0.24	3.09	1.18	0.08	2.93	1.54	0.47	3.27	2.16
Sort (φ)	0.38	1.87	0.87	0.96	2.05	1.36	0.59	1.70	1.24	0.57	2.01	1.35
Skl (φ)	-0.62	0.67	-0.02	-0.39	0.81	0.13	-0.63	0.41	-0.06	-58.00	0.54	-1.73
KG (φ)	0.53	2.22	1.23	0.59	1.97	1.04	0.63	1.84	1.13	0.54	2.35	1.05

Table (3): Grain size parameters and textures of sediments of different clusters.

Parameter	Cluster I			Cluster II			Cluster III		
	Min	Max	Average	Min	Max	Average	Min	Max	Average
Gravel %	0.00	2.96	**0.67**	11.40	48.76	**25.12**	0.00	9.45	3.08
Sand %	95.63	99.92	**98.10**	50.40	86.64	**73.31**	82.89	95.09	91.00
Mud %	0.04	4.03	**1.23**	0.02	7.68	1.57	0.61	17.05	**5.92**

In land filled areas; the beach sediments are coarse grained and poorly sorted. Grain size increases and sorting improves from low to high water mark due to the change of hydrodynamic conditions. In dredged areas, fine sediments are dominant. Generally, dredging and landfilling increase turbidity, change water circulation and sediment distribution patterns, and may destroy entire reef systems. Waves and current move turbid water further offshore to other places with living corals on the adjacent reef flat and reef slope. Corals and other organism mostly may be destroyed if such activities continue.

5. GEOCHEMICAL PARAMETERS

The chemical characteristics of the marine sediments and metals are released to the environment as a result of a variety of human activities such as sediments released through beach enhancement, coastal constructions, landfilling and dredging, heated and chemically treated effluent water from power and desalination plants and oil and hydrocarbons lost from drilling operations and pipeline. The distribution, movement and storage of contaminants in coastal seawater have a substantial influence of the marine ecology and environmental chemistry. The impact of release of industrial wastes in the sea depends on various factors, e.g., local meteorological conditions (the wind effect is important in controlling turbidity), hydrodynamic regime of water mass; and the amount of frequency of the discharge (Boughriet *et al*. 1994). The current research on the anthropogenic effects on the marine environment has been carried out on the coastal area, where the human impact may be increasingly affecting the oceanic realms (Omori and Norman, 1995)

Organic Carbon (OC) and Total Organic Matter (TOM)

The Hurghada Marina sediments have the highest total organic matter content that ranges from 1.22% to 4.72% with an average of 2.58. The sediments also have the highest organic carbon content which ranges from 0.68% to 2.62% with an average of 1.43% (Table 4). The total organic matter content of sediments of the second tourist project is high and ranges from 0.22% to 3.86% with an average of 2.28% and the organic carbon content ranges from 0.12% to 2.14% with an average of 1.27% (Table 4). Mansour (1999) has found that the terrestrial materials rich in organic matter and the high organic productivity are the two main reasons for the high content of organic matter in Sharm Abu Makhadeg area.

Cluster analysis; Based on total organic matter (TOM) and organic carbon (OC) three main clusters were obtained (Fig. 6). The first cluster includes 34 samples and is characterized by the highest values of TOM (2.57%), OC (1.43%) and carbonate (72.41%). This cluster includes all samples of the central marina (19 samples) and the second tourist site (15 samples). The main impact of these two areas is dredging the tidal flat that composed mainly of biogenic materials, and most landfill is from these materials. Cluster 3 (45 samples) has also high values of TOM (1.87%) and OC (1.04%). It includes most samples (34) of the oil exploration site. The second cluster is poor with TOM (1.07%), OC (0.59%) and carbonate (18.34%). It includes samples from the first tourist site, a few samples of the second tourist site and the central marina. Dredging is the reason for the high organic content in the central marina and the second tourist site whereas in the oil exploration site drilling mud, oil wells and oil extraction are the main reason. Dredging of the tidal flat reveals fine sediments and concentrates organic matter and trace metals in confined pools. Moreover, the shoreline change in these areas has produced semiclosed areas, artificial lagoons and quiet water areas where organic productivity increase. Contribution of the landfilling materials of terrigenous origin from the areas close to the high mountain of igneous and metamorphic rocks decreases the carbonate content in the first tourist site.

Table (4). Total organic matter, organic carbon and carbonates of all samples of studied areas.

Site	Desert Rose site.			Master Line site			Hurghada Marina site.			Magwish Company site.		
Parameter	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
TOM%	0.18	1.68	0.92	0.22	3.86	2.28	1.22	4.72	2.58	1.16	1.48	1.74
O.C.%	0.10	0.94	0.51	0.12	2.14	1.27	0.68	2.62	1.43	0.64	0.82	0.97
Carb.%	8.20	36.60	17.10	12.90	92.90	36.30	84.60	68.44	26.30	53.90	42.78	4.01

O.C. : Organic carbon TOM : Total orgainic matter Carb.: Carbonates

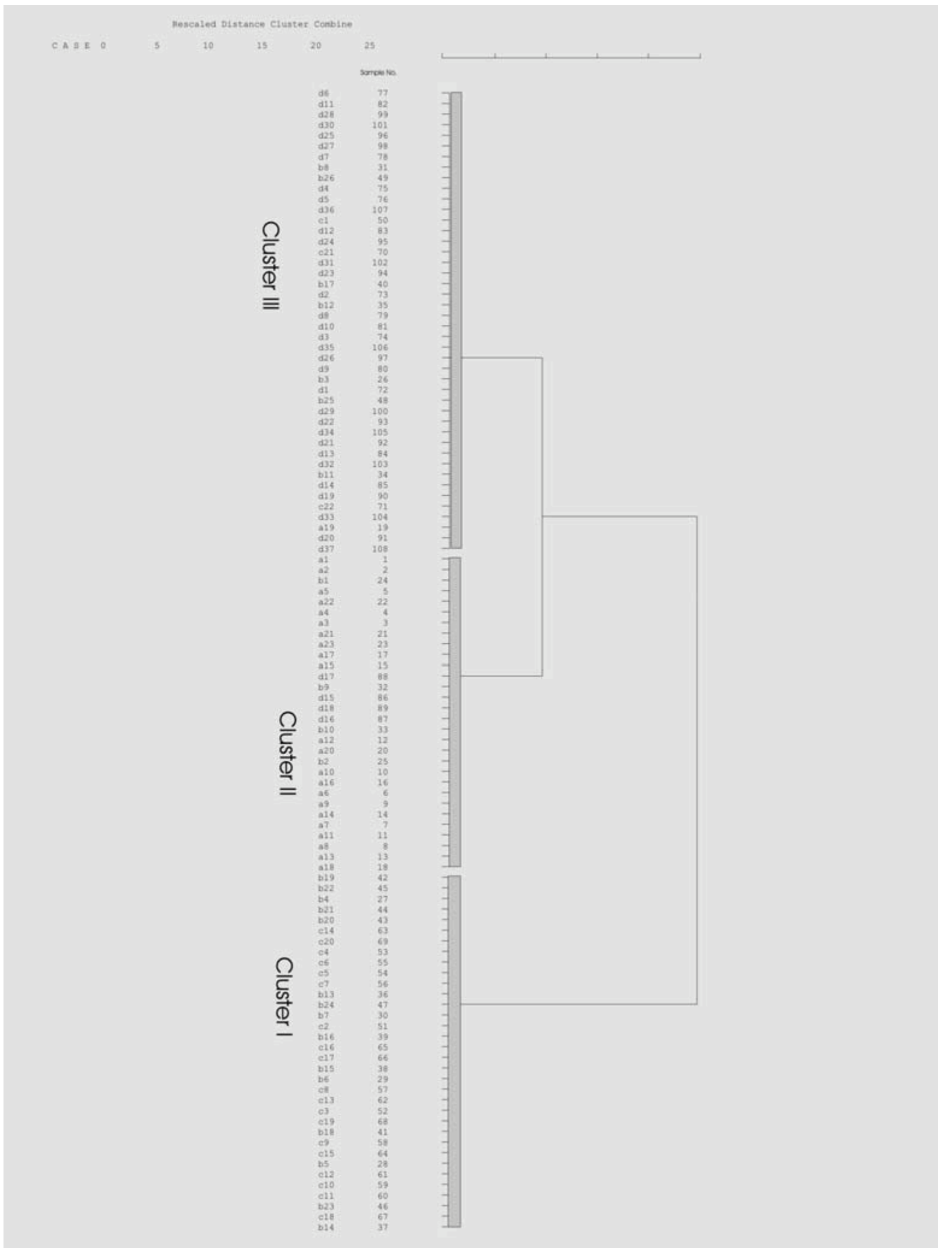

Fig. (6). Dendrogram of cluster analysis using Ward Method exhibiting cluster of total organic matter and carbonate.

Total Carbonates:

Carbonate sediments are composed largely of calcium carbonate. They are made up for the most part of the skeletal parts of marine organisms. Contributions from pre-existing limestone or from chemical precipitation are relatively insignificant in most marine environments.

Carbonate sediments are composed mainly of organic skeletons, their make-up and origin is, to a great extent, a biological problem. Composition of the sediments is strongly influenced by the same ecological conditions, which control the distributions of organisms.

El-Mamoney (1995) found that the carbonate contents of the marine sediment along a distance of 500 m in the sea of areas in front of wadi El Hamara, El Ash, Abu Shaar, El Jemal and Khasier varies from 21.75% to 98.29%. Mansour *et al*., (1997) found that the carbonate content varies from 19.38% to 100% with an average of 63.26% of the beach and intertidal sediments allover the coastal area from Gemsa to Marsa Alam.

Maxwell (1968) classified sediments according to carbonates contents to high carbonate (>80%), impure carbonate (80% – 60%), transitional (60% – 40%), terrigenous (40% – 20%) and high terrigenous (<20%). According to this classification, sediments of the first tourist site are high terrigenous to terrigenous, sediments of oil exploration site are mostly transitional with some terrigenous samples. Most sediments of the second tourist site are transitional with some samples of high carbonate content. Nearly all samples of the central marina are impure carbonate and high carbonates. The distribution of carbonates of all sediments in the different studied areas reflects their origin and the effect of dredging and landfilling processes. The sediments of the central marina and the second tourist site have high carbonate content of biogenic origin due to the dredging in coral reefs areas. The sediments of the first tourist site and the site of oil exploration have the lowest carbonate contents due to the landfilling by terrestrial sediment in the beach and intertidal area (Table 4).

Major Elements:

The major elements determined in this study include Ca, Na, K, Mg, Sr, Mn, and Fe. Most of these elements are derived mainly from the hinterland source rocks of the Basement complex. However Ca, Mg and Sr are mainly derived from the marine biogenic sources.

Calcium (Ca)

Calcium is one of the major constituents of the earth's crust and in the biogenic componants. Calcium occurrence in the fine fraction sediments may has some special emphases to the anthropogenic impacts mainly from construction residuals as concrete, cement materials and gypsum. El Askary *et al*. (1988) pointed that, there is a slight tendency for increasing of magnesium oxide as calcium oxide increasing in both beach and bottom sediments in the northern Red Sea. El-Sayed (1984) found that the calcium contents of the reefal sediments of Hurghada average 21.7%. Mansour *et al*. (2000) found that calcium contents of the marine sediment of thirteen areas along the Egyptian Red Sea coast from Hamata to Hurghada range from 6.41% to 73.9% with an average of 15.94%.

Calcium content of the investigated sediments ranges from 0.14% to 32.60% with an average of 15% (Table 5). The first tourist site has low Ca content ranges from 0.14% to 18.50% with an average of 5.11% (Table 5). Sediments of the second tourist site have high Ca content ranges from 2.87% to 28.41% with an average 17.55% (Table 6). Calcium content is also high in the central marina and ranges from 8.75% to 32.6% with an average of 22.34% (Table 5). This relatively high content of Ca is resulted from coral rock fragments of the dredging areas. Calcium content in the oil exploration site ranges from 6% to 21.36% with an average of 14.26% (Table 5). The general low content of Ca in sediments of the studied sites and especially,