Bull. Inst. Oceanogr. & Fish. ARE, 14 (1) 1988: 55-66.

SEDIMENTOLOGY OF SOME COVE AND MANGROVE DEPOSITS ALONG THE SOUTHWESTERN COAST OF THE GULF OF AQABA

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ABSTRACT

The grain size analysis and the mineralogical examinations of shore sands of Sharm El-Maiya cove and some mangrove deposits, showed that these deposits constitute two different heavy mineral provinces.

The Sharm El-Maiya cove province is characterised by: amphiboles, 30.3%; zircon + tourmaline + rutile, 8.1%; and pyroxenes, 6.7%. The mangrove province is characterised by amphiboles, 26.8%; and pyroxenes, 22.2%.

The cove prevince is highly concentrated in opaques comparably to its oniginal provenance, meanwhile the mangrove one contains less amounts of opaques than its own provenance.

The sands of the cove province are in fact products of disintegration of Sharm El-Sheikh sandstone, conglomerate and breccia filling deposits of the prePleistocene age, and the Quaternary coralline limestone. While sands of mangrove province are derived from the granitic source rock as well as the metamorphic rocks.

The cove sands have a wide range of variation in their grain size relative to those of the mangrove. The cove sands are moderately sorted, meanwhile the mangrove sediments are poorly sorted.

THe shore sands of Sharm El-Maiya cove are considered as a good coastal placers for zircon and hence have a relatively high ecenomic value. The concentration of zircon in these deposits has an average of 6.8% and in some samples it reaches 21.8%.

The distribution of opaques and amphiboles in beach sands of Sharm El-Maiya cove has been used to explain the general direction of the prevailing long shore current.

The ratios of the stable/unstable heavy mineral ratio reflect the immaturity of both the mangrove and Sharm El-Maiya cove sediments.

INTRODUCTION

Recent shallow water sediments along the Sinai Peninsula shores have received little attention, although they may contain sedimentary minerals of high economic value. Most studies on these sediments deal with randomly collected samples.

The present study deals with two sample groups that collected by hand during the peried 22-28 March, 1988. The first represents El-Maiya cove beach in the area of Sharm El-Sheikh,(27° 51' 51" - 27° 51' 45"N) while the second group was collected from the mangrove forests extending (28° 11' -28° 18'N) along the western coast of the Gulf of Aqaba.

Sharm El-Maiya cove forms an elongate indentation of the sea in the coastal stretch extending between the Gulf of Suez and the Gulf of Aqaba. Its outlet opens to the south (Fig. 1). It is consisted of two halves separated by a narrow passage less than 200 m wide. The outer or the southern part has a funnel shape and is directly connected to the Red Sea proper.It is exposed to the open sea waves, and hence its coast is built up of a high limestone cliff leaving no beach nor bench. The inner part has an oval shape with a gently sloping sandy beach. It is boardered from the east by an Oligocene and pre-Pleistocene breccia and conglomerate filling deposits overlained by sandstone and coralline limestone, intercalated with shales, and conglomerate of post-Pleistocene age (Omara,1959). The sandstone is absent in the western beach.

The mangrove forests (AL-Monqataa at the north and Al-Rowaisia at the south) extend in the northern part of the alluvial fan of Wadi-Kid. They are described by (Por, Dor, and Amir, 1977).

Wadi-Kid receives its detritus from the magmatic, metamorphic and sedimentary high mountain ridge that extends parallel to the western coast of the Gulf of Aqaba. It rises approximately 1000 m above the sea level at 5 - 12 Km from the cost. Wadi-kid is the main contributor to the studied mangroves.

The objectives of the present study are to identify the following:

1- The variation in the grain size and mineralogy of sediments in the investigated areas.
2- The heavy mineral province or provinces and the type of provenance from which these sediments are derived.
3- The maturity of the heavy mineral provinces of the studied areas.
4- To determine the economic value of these deposits.
5- To elucidate the direction of sand movement in Sharm El-Maiya beach.

MATERIALS AND METHODS

...ing of Beach Sands

...n shore samples were collected in couples above and below sea

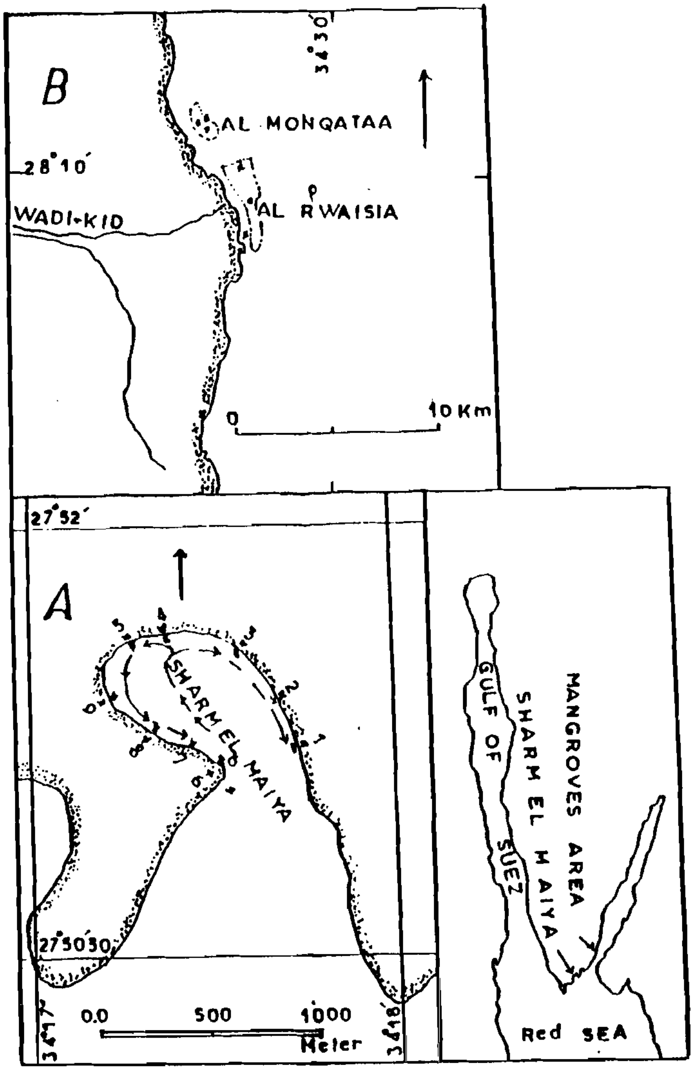

Fig. (1)
Outline maps showing the sampling localitiesin
(A) Sharm El-Maiya Cove and (B) Al-Monqataa
and Rowaisia mangrove forests.

level, at about 200 m interval along the shore of Sharm El-Maiya cove. In the mangrove area. 7 samples were collected from different parts, (Fig. 1 and Table.1).

Laboratory Studies

The washed and dried samples were treated with a mixture of chloroform and carbon tetrachloride and washed with eathyl alcohol to remove the high amounts of hydrocarbons contaminating the sediments. After that, samples were again dried in a drying oven, and analysed for grain size by sieving for 20 minutes in a set of standard sieves. Statistical textural parameters were calculated by using Folk (1974) coefficients.

TABLE 1
Textural parameters of sediments of Sharm El-Mayla & Mangroves
in 0 phi value

		M_Z	1	SK_1	K_G
Sharm El-Maiya	Rang	-0.031 - 3.017	0.335 - 1.907	-0.386 - 2.551	-0.82° - 5.327
	Average	1.233	1.011	0.471	0.835
Black Sand	Range	-	1.345 - 1.572	-0.263 - 0.017	0.990 - 2 015
	Average	2.250	1.458	0.14	1.503
Wadi Kid mouth & land side of mangrove	Range	1.283 - 2.117	1.371 - 1.661	-0.093 - 0.510	0.579 - 0.689
	Average	1.700	1.516	0.301	0.634
Samples from Mangrove	Range	0.940 - 2.317	0.980 - 1.694	-0.363 - 0.109	0.512 - 0.940
	Average	1.664	1.344	-0.224	0.690

The 2-4 o fraction was separated into heavy and light fractions using bromoform (sp.gr. 2.9). The different heavy mineral species were identified under the petrographic microscope. Quantitative determination of the different opaque minerals was carried out using oil immersion under the reflected light.

The total carbonate content was determined gasometrically using the calcimeter.

RESULTS AND DISCUSSION

The averages and the ranges of grain size analysis and the heavy mineral analysis are represented in Tables 1 and 2, respectively.

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TABLE 2

The heavy mineral composition of Sharm El-Mayia and Mangrove deposits IR = Index ratio,
S = Stable or resistant minerals, U = unresistant minerals.

		Opaques	Hornblende	Pyroxenes	Zircon	Rutile	Sphene	Monazile	Epidotes	Mica	I.R.	S/U
Sharm El-Mayia	Range	25.9 - 67.6	8.4 - 48.7	0 - 24.3	0.9 - 13.2	0.0 - 2.8	0.0 - 3.2	0.0 - 2.8	0.0 - 1.2	0.0 - 12.7	0.1 - 7.5	0.20
	Average	46.8	30.3	6.7	6.8	1.1	0.9	0.7	0.4	3.4	6.3	
Black Sand	Range	74.9 - 80.8	-	-	18.9 - 24.7	0.0 - 0.4	0.0 - 0.4	-	-	-	96.7 - 98.1	
	Average	77.0	-	-	21.8	0.2	0.2	-	-	-	97.4	
Wadi Kid and land side of Mangrove	Range	53.2 - 54.9	16.6 - 21.9	11.1 - 13.3	0.8 - 1.2	0.0 - 0.8	0.0 - 0.4	5.9 - 9.9	0.0 - 0.4	0.8 - 1.2	3.9 - 4.7	0.4
	Average	54.2	19.2	12.2	1.0	0.4	0.2	7.9	0.2	1.0	4.3	
Mangrove lagoon Channel & Reef flat	Range	21.3 - 54.3	19.2 - 45.5	14.9 - 32.9	0.0 - 15.3	0.0 - 0.9	0.3 - 4.7	0.0 - 1.2	0.0 - 1.2	0.0 - 6.6	0.1 - 2.6	0.13
	Average	30.4	26.8	22.2	4.3	0.3	1.3	0.5	0.3	2.2	1.7	

Grain Size:

The averages of the mean grain size diameter and sorting fluctuate along the shore of Sharm El-Maiya cove,but there is a general tendency for sediments to increase in size and decrease in sorting from the eastern side to the west, (Fig.2).

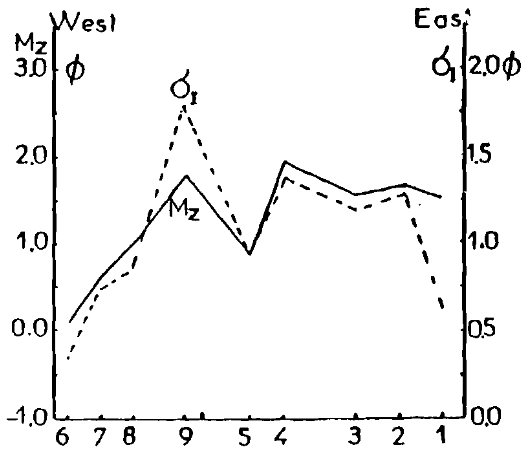

Fig. (2)
The variation of mean grain size and sorting along Sharm El-Mayia Cove shore.

At the eastern end of the cove, the sediments vary in the mean grain size from -0.017 to 1.593 o, i.e. from granular very coarse sand to medium sand, while in the western end they vary from granular coarse sand to coarse sand with a mean grain size value restricted between -0.030 and 0.593 o. The middle of the cove is generally characterized by different types of sands that vary from coarse to very fine size grades, which mean that those sands are finer than those of the eastern and western sides of the cove. Most of the cove beach sands are well sorted, and the coarser grained sediments are better sorted than the finer.

These findings suggest a limited degree of variation of such environmental condition of deposition in the different parts of the shore zone. The sands of Sharm El-Maiya, Wadi- Kid and the land side of the mangrove forests generally constitute excess fine material (i.e., fine skewed) with an average skewness values between 0.471 and 0.301

Mangrove deposits are finer than cove ones. They vary from coarse sand at Wadi-Kid mouth to fine sand in the mangrove channels and lagoons. In general, they are poorly sorted and have an excess of coarse material, which is of biogenic origin. They range between very platykurtic to platykurtic (i.e the central portion of their probability curve indicates better sorted than the tails). The very platycurtic samples (No. 3 and 5 in the cove and in the mangrove) may indicate a multi-source derivation.

Mineralogical Composition:

The heavy mineral composition of Sharm El-Maiya and the mangrove sediments is presented in Table (2). The heavy mineral suite of Sharm ElMaiya beach deposits consists almost exclusively of opaques (46.8%); hornblende (30.31 %); zircon(6.80 %); pyroxenes (6.80 %)and mica(3.40 %). Rutile (1.1%); sphene (0.7%); monazite (0.9%); epidote (0.4%); staurolite (0.2%); and tourmaline (0.2%); are present in a very small amounts. Traces of actinolite, anatase, and apatite are also present. Few oxidised grains of pyrite are recorded.

The heavy mineral suite in the Monqataa and Rowaisia mangrove deposits is characterized by: opaques (30.4%); hornblend(26.8%); pyroxenes(22.2%); zircon (4.3 %) and mica (2.2%). Associated minerals are actinolitetremolite (1.7%); spene (1.3%); staurolite (0.7%); monazte (0.5%); epidotes (0.3%); garnet(0.3%); and rutile(0.3%). Traces of apatite are recorded.

The density of distribution of opaques and to some extent the zircon + tourmaline + rutile, (ZTR), in the cove deposits shows a negative proportionality to the grain size diameter, where they are more frequent in the finer grained sediments. In contrary, hornblend is highly concentrated in the coarser grained sediments, (Fig.3). Meanwhile, opaques and (ZTR) are highly concentrated in the less sorted sediments. The reverse is generally observed for hornblend. This clear relation between the principal constituting minerals and the mean grain size as well as the sorting degree is not present in the mangrove deposits.

The density of distribution of opaques and amphiboles in the investigated arease (Fig. 4) shows that they are inversely proportional to each other. This finding agrees with that reported by McMaster (1960).

Irrespective of the fluctuations in the percentages of the different minerals along the cove beach, hornblend shows a general tendency to increase in concentration toward the middle of the beach (Fig. 5). The least amount of hornblend is found in the eastern and western ends of the cove. The maximum amount is met with in the middle northern point (No. 4) of the cove. The density of distribution of both opaques and ZTR are highly comparable.

The Sharm El-Maiya cove and the mangrove forest sediments constitute two different provinces, (Fig. 6 a). Sharm El- Maiya cove is characterized by the hornblend-zircon province, and the mangrove forests are distinguished by the hornblende-pyroxene province.

Ayalon (1976) studied the mineralogical composition of the Wadi-Kid area. He reported that its province is characterized by: amphiboles (18%

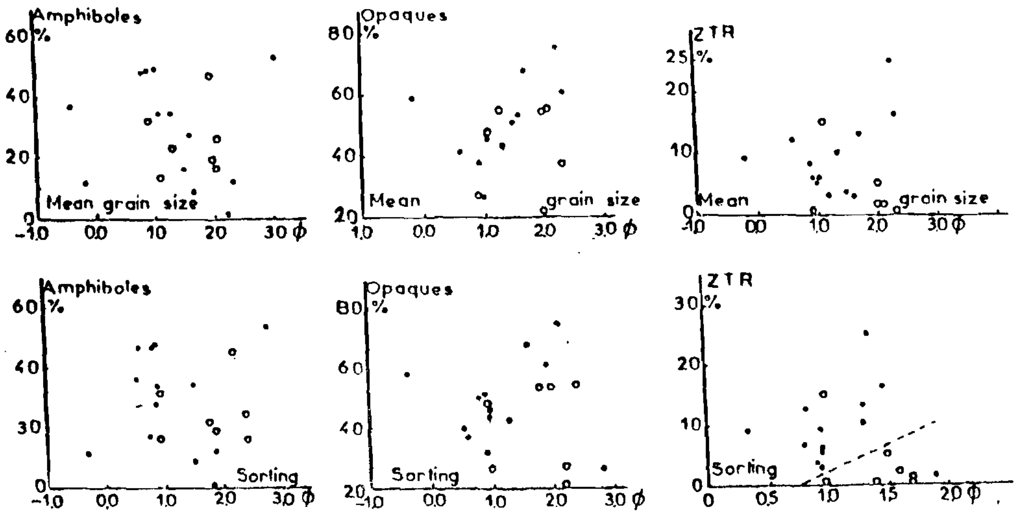

Fig. (3)
Plots of the mean grain size and sorting v.s. the most dominant mineral groups. ° = Cove beach, ° = Mangrove.

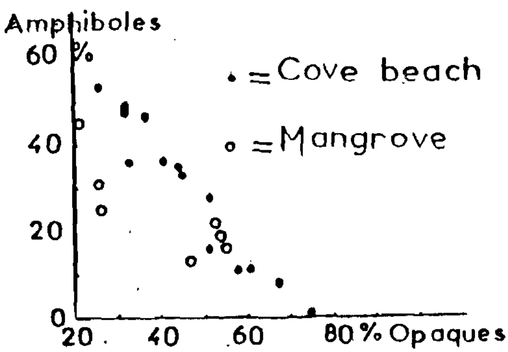

Fig. (4)
Relationship between opaques and amphiboles.

, pyroxenes (12%) , sphene (8%) , mica (8%), zircon + tourmaline + rutile (4%), and apatite (4%). According to the present study the heavy mineral assemblage of Wadi Kid and the mangrove shore have similar averages of amphiboles and pyroxenes. They are deficient in ZTR, sphene and mica. More deeper sea-ward, the mangrove channels and lagoons are dominated with the relatively low specific gravity heavy minerals as amphiboles and pyroxenes, and are deficient in the higher sp. gr. minerals as ZRT and sphene. This may suggest that the roots of the mangrove plants act as a filter concentrating the lower sp. gr. heavy minerals in their lagoons and channels.

The average percentage of the heavy minerals in the beach sands of Sharm El-Maiya cove is (6.3%) which is lower than that of Mersa El-Aat embayment, (Nawar, 1989). The black sands in Sharm El-Maiya cove are composed almost exclusively of opaques and zircon which constitute about 97% of the black sands, in the cove. Meanwhile, in Mersa El-Aat embayment opaques and zircon form only about 57% of the black sands. The black sand ribbons in the cove are restricted to its eastern side. They are 15 - 25 cm wide and reach about 2.5 cm thick.

The black sands produced in Mersa El-Aat embayment are associated with a mederately well sorted relatively coarser grained concentrates (M_Z = 1.44 0 & σ_I = 2.25 0), and those produced in Sharm El- Maiya cove are found in a poorly sorted relatively finer grained concentrates (M_Z= 2.25 0 & 0_I= 2.25 0), and those produced in Sharm El-Maiya cove are found in a poorly sorted relatively finer grained concentrates (M_Z= 2.25 0 & σ_I = 2.25 0).

According to Frank (1973), the heavy mineral grain size on beaches in the vicinity of Apalachiocola, Florida, is inversely related to energy level of the incident waves. The higher energy regime produces the finer heavy mineral concentrates. Referring to the foregoing findings and facts the black sands of Sharm El-Maiya cove indicate a relative higher energy level of incident wave, and hence a higher energy of deposition in comparison with that of Mersa El-Aat embayment.

Jacob et al. (1980) examined the heavy mineral placers of the eastern African coast in Kenya. They found that the average concentration of the heavy minerals in the coastal sands is 14%, and the average percentage of zircon in the heavy fraction is 0.5% by weight. They considered that concentration of zircon is of a good economic value.

The average percentages of the heavy minerals in the beach sands of Sharm El-Maiya cove is (6.3%) as mentioned before and in Mersa ElAat embayment is (18.5%) by weight. In the same time the average percentages of zircon in the heavy mineral fraction are 6.8% and 4.3% by volume, respectively. The preceding facts confirm that the beach sands of Sharm ElSheikh region represent an economically very intersting zirconium deposits.

The total carbonate content of both the cove beach and the mangrove deposits are determined. The total carbonate content of the cove beach sedments ranges ranges between 10 and 57.5% with an average of 30.8%. That of the mangrove sediments ranges between 55.5 - 80.0% with an average of 71.3%. The evidently high carbonate content in the mangrove sediments is referred to calcarious debris derived from the bordering reef flat.

Considering the above observations we have to conclude:

- Sharm "El-Maiya" cove sediments are related to the hornblende; zircon province. The Sharm El-Sheikh sandstones are the main contributor to it and are responsible for its high content of opaques and zircon. The conglomerate and breccia filling deposits as well as granites contribute to this province also.
- The mangrove deposits are attributed to the hornblende pyroxene province. It is contributed from the Pre-Pliocene magmatic (acid and intermediate) and metamorphic source rocks which are responsible for amphiboles, pyroxenes and mica; as well as the granitic source rock that is responsible for the relatively high sphene content. Accordingly, it has a lower concentration of opaques and zircon.
- The heavy mineral assemblages of both the cove beach and mangrove are immature.
- The general density of distribution of opaques and amphiboles along the cove beach showes that the sea current enters the cove directly toward the northern middle point of the beach, and then bifurcates into two (eastern and western) longshore currents, (Fig. 1),
- The Sharm El-Sheikh beach sands are characterized by an economically considerable concentration of zircon and ilmenite. This deserves more detailed study.
- The beach sands of Sharm El-Mayia cove are deposited under a high energy level relative to those of the Mersa El-Aat embayment.
- Ilmenite is the most abandant opaque mineral in the investigated areas.It averages between 62.3 and 66.0% of opaques in Mersa El-Aat and Sharm El-Maiya beach sanmds and 83.0% of opaques in the mangrove sands, but it forms 90.9% of opaques in the black sands of Sharm El-Maiya cove.
- Magnetite is more concentrated in the embayment opaques (30.2%) than in the cove sands (9.0%). Its concentration is very low in the mangrove deposits (8.0%) in comparison with the source (Wadi-Kid) detritals.
- The mangrove deposits are characterized by higher concentration of carbonates in comparison with the cove beach deposits.

REFERENCES

Folk, R.L., 1974. **Petrology of sedimentary rocks.** Hemphill Publishing Co., Texass, pp. 182.

Frank, W.; Stapor Jr., 1973. Heavy mineral concentrating processes density shape size equilibria in the marine and coastal dune sands of the Apalachicola, Floride region, **J. Sed. Pet.** Vol. 43 (2) p: 396-407.

Jacob, K.H.; E. Gock and J.H. Schroeder, 1980. Coastal heavy mineral deposits of Kenya, characteristics, New methods of processing, economic potentials, **Proceedings of the symposium on the coastal and marine environment of the Red Sea, Gulf of Aden and tropical western Indian Ocean, Khartoum.**

McMaster, L. Robert 1960: Mineralogy as an indicator of beach movement along the Rohode Island Shore, **J. Sed. Pet, Vol. 30, (3).**

Nawar, A.H.,1989. Texture and mineralogy of the nearshore sediments of Mersa El-Aat embayment, Sharm El-Sheikh, **1st conf. Geoch.Geology Dep., Fac. Sci., Alex. Univ.,** Vol. II.

Omara, S., 1959. The geology of Sharm ElSheikh sandstone Sinia. **The Egyptian Jour. of Geology,** Vol. III (1).

Por, F.D.; I. Dor, and A. Amir, 1977. The mangal of Sinai: Limits of an ecosystem, **Helgolander wiss. Meeresunters.** 30: 295-314.