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Economic heavy minerals in the coastal area between Burg EL-Burullus and Baltim north of Nile Delta, Egypt

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Abstract : The study area between Burg EL-Burullus and Baltim contains many of geomorphologic units such as sand dunes, beaches, lagoon, and reclaimed lands. The heavy minerals are concentrated in the coastal sand dunes and the beaches of EL-Burg and Baltim. The heavy minerals in the study area are Opaques, Hornblende, Augite, Zircon, Epidote, Tourmaline, Garnet, Rutile, Monazite and Others (Staurolite +Biotite). The heavy minerals in the coastal sand dunes are higher than that in the beach of EL-Burg area. Higher density minerals are increase in sand dunes, while decrease in the beach, the lower density minerals increase in beaches and decrease in coastal sand dunes.
Keywords: Heavy minerals – Sand dunes – Shoreline – Nile Delta.

Introduction:

Before the construction of Aswan High Dam in 1964 the Mediterranean sea was annually receive 134 Million tons of sediments and about 55.5 Billion m3 of water (Abu-Zeid and El-Shibini[1], Sharaf El Din[2]). After the construction of Aswan High Dam the quantity of sediments (arrived to Mediterranean Sea) has been decreased, thus these decreasing of sediments negatively affected on the agriculture lands and the most coastal geomorphologic units.

Many authors studied the sedimentology and mineralogy of the Nile Delta coast in relation with accretion and erosion of beach (Anwar [3], El-Bouseily and Frihy[4], Frihy and Komar[5], El-Asmar[6], Ahmad[7]) and others. They suggested that near the river promontories the sand is finer and the coarse sand transported to accreted areas by longshore currents. They added that the heavy minerals accompanied with the eroded areas near the river mouth of the finer sediments, and decrease with longshore currents in the accreted areas. The most dominant minerals in the dune sand are comprised of opaque minerals, amphiboles, pyroxenes, epidotes, garnet, zircon, rutile, and tourmaline (Table 2). These heavy mineral assemblages characterize the Nile deposits (Shukri [8]).

El-Fishawi and Molnar[9] suggested that the normal heavy mineral variation of the shoreline show a significant trends in general, where the heavy residues, opaques, garnet, zircon, tourmaline, and rutile markedly increase while amphiboles and pyroxenes decrease in moving from the breaker zone across the beach and backshore and up to the dune.

The coastal area from Gamasa and Burg EL-Burullus contain many important geomorphologic units such as coastal sand dunes, beaches, wetlands and reclamation lands. Coastal sand dunes and beaches are very

important units in the area between Gamasa and Burg EL-Burullus, where the coastal sand dunes are two type old and young. the young dunes are two type, barchans and longitudinal. He old dunes formed from the sands derived the eroded old Sebennitic Promontory that ceases about 2500-2000B.P. (Stanley etl [10]). The young dunes are mobile composed of fine sands, located along the shoreline and extend backshore to maximum 1000 m.

The Barchans are located onBaltim and Burg EL-Burullus beaches where there are plenty of sand accumulated on the beach and backshore is very narrow (Ahmed and El-Asmar [11], Ahmed [12]). The longitudinal dunes are located along Gamasa coast and southward where a plenty of sand and wide backshore are present. According to El-Asmar and Haifaa [13] the coastal sand dune area appears dimensioned in about 94% form 1984 being 165.4 km2 to 9.3km2 in 2010. A gradual decrease from 110.3, 61.5, and 64.3 km2 from 1997, 2003, and 2006, respectively these decreasing due to the effect of reclamation and fish farm spreading.Erosional beaches are characterized by the concentration of high- density heavy minerals while relatively low-density heavy minerals such as amphiboles and pyroxenes are concentrated in the accretional areas. Low-density heavy minerals are winnowed by waves and current and move offshore (Frihy and Komar [5]).

According to many authors such as (El-Fishawi and Molnar[9], Frihy[14], Frihy and Lotfy[15], El-Askary and Lotfy [16]) the finer grained and high density heavy minerals (opaques, garnet, rutile, zircon and monazite) are concentrated in eroded areas such as the Nile Delta promontories at Damietta and Rosetta, while the areas of the coastline which suffering from accretion with shoreline advance are associated with concentration of coarser sediments and the lower density heavy minerals (augite, hornblende, tourmaline and epidote). Where the lower density heavy minerals and the light minerals (quartz and feldspars) removed by the longshore currents to the accreted areas.

Materials and Methods

Study area is located between Burg EL-Burullus and Baltim (Fig. 1), where the area contain belts of coastal sand dunes of Barchan and Longitudinal types and beaches. Two profiles perpendicular to the shoreline were studied for the heavy minerals concentrations (Fig. 2 and Table. 1).

About 11 sedimentary samples were collected for this study According to Carver [17] the sand fractions of 0.125 to 0.063 mm were separated using bromoform of specific gravity 2.89 as separating media into heavy and light minerals. The heavy and light minerals were individually washed and weighted. The heavy minerals were mounted in permanent slides using canada balsam (Allman and Lawrence [18]). The opaque and non-opaque heavy minerals are calculated, and the individual non-opaque heavy minerals are calculated as a relative percentages of total non-opaque minerals by counting about 400 grains per slide along randomly chosen traverses using the polarizing microscope (Dryden [19]).

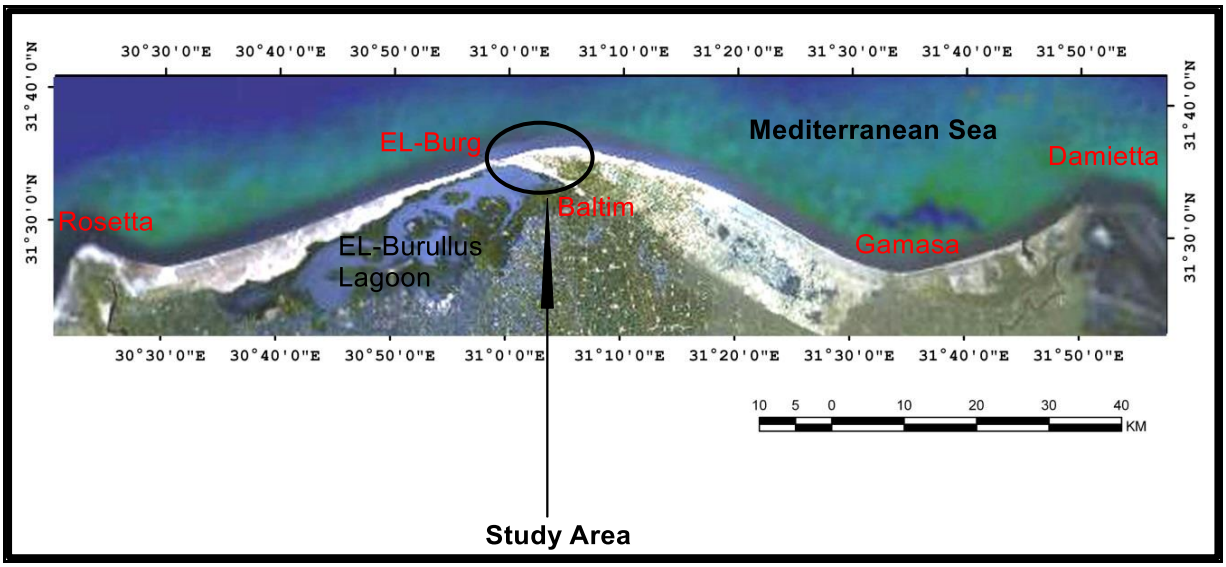

Fig. (1): Location map for the area between Burg EL-Burullus and Baltim

Table.(1): Locations of samples in the study area

Samples	Location	Samples	Location
1	Shoreline EL-Burg	**7**	Lee side middle dune
2	Backshore, after the first sample by 50 m	**8**	Right side of international road toward Baltim
3	On the bottom of dune	**9**	Shoreline, east of Baltim resort
4	Top of dune	**10**	Backshore, east Baltim resort
5	Stoss side bottom dune	**11**	Lift side of international road toward Gamasa
6	Lee side bottom dune		

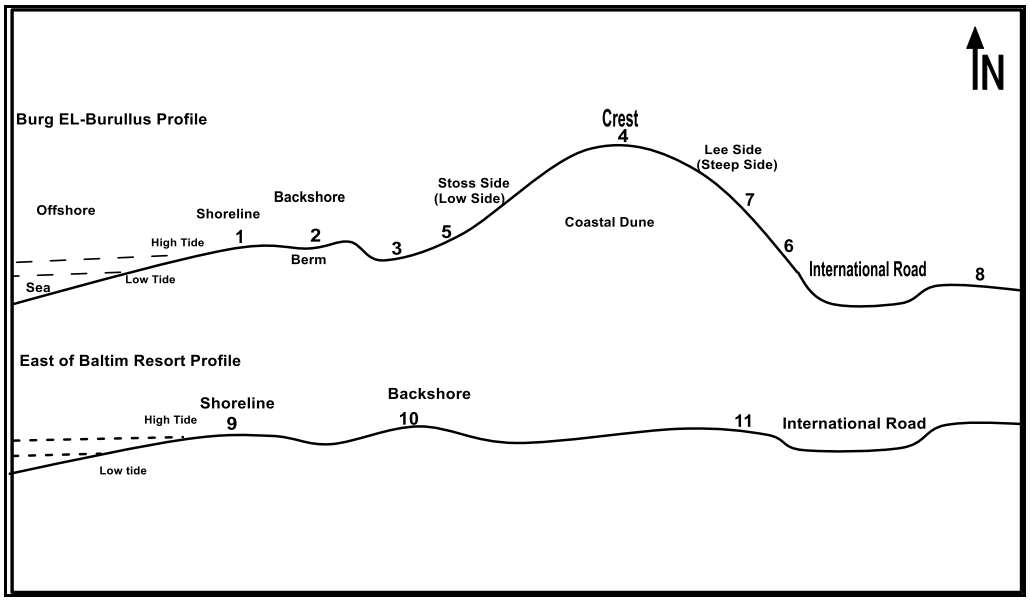

Fig.(2): Vertical Profiles perpendicular to the beach from shoreline to dune in the area between Burg El-Burullus and Baltim

Results and Discussion

In the study area , two profiles were studied, the first profile in the Burg EL-Burullus beach extend from shoreline to right side of international road (shoreline, backshore, top of dune, stoss side bottom, lee side bottom, middle lee side, right side of international road toward Baltim). The second profile in the east of Baltim resort extend from shoreline to lift side of international road toward Gamasa (shoreline, backshore, lift side of international road) (Table. 2, Fig. 2).

In the first profile, the total heavy minerals increase from shoreline to the crest of dune (Fig. 3). The total heavy minerals in the EL-Burg dune increase from base to the crest of dune, where the total heavy minerals in the lee side of dune more than the stoss side of the dune. After EL-Burg dune on the right side of international road (toward Baltim), the total heavy minerals decrease. The total heavy minerals are in the following order:shoreline< backshore< top of dune> stoss side bottom< lee side bottom>middle lee side>right side of international road toward Baltim(Table. 2 and Fig. 3).

Opaques, zircon, rutile, monazite, garnet and others (Staurolite +Biotite) (higher density minerals) in EL-Burg dune are higher than that in the EL-Burg beach. Where, hornblend, augite and tourmaline (lower density minerals) are higher in the EL-Burg beach than that in EL-Burg dune (Table. 3 Fig. 4).

In the second profile, the total heavy minerals increase from shoreline to backshore and decrease from backshore to lift side of international road. The total heavy minerals in the following order: shoreline<backshore> lift side of international road. Sand samples from the shoreline and backshore of Burg EL-Burullus have a lower content of total heavy minerals compared with the shoreline and backshore samples of east Baltim resort.Opaques, zircon, monazite, garnet, tourmaline and others (Staurolite +Biotite) of shoreline of east Baltim resort higher than that in backshore . Where, hornblend, augite, epidote and rutile are lower in shoreline than backshore of east Baltim resort (Table. 2).

Finally, there is a relationship between beach and dunes in EL-Burg area, where the higher density minerals are higher in dunes and lower in beach., while the lower density minerals are higher in beach and lower in dunes. The heavy mineral variations normal to the shoreline show that the opaques, garnet, rutile, zircon and monazite markedly increase while hornblende, augite, tourmaline, and epidote decrease in moving from the beach to the dunes, where the all heavy non opaques minerals are present in a different percent along the two profile due to the type of beach and the main geomorphologic units (Fig. 4,5). These results are in agreement with (El-Fishawi [9]). The heavy minerals concentration of the study area changed when the beach changed or/and by removing the coastal sand dunes. The two studied profiles are different from each other due to the type of beach and the presence of sand dunes, where the concentrations of heavy minerals changed along each profiles (Fig. 5).

Mineralogical composition of the heavy minerals:

The optical properties of nine heavy minerals under the polarizing microscope representing the main contents of the heavy fraction of the sediments are given in the following:-

1-Opaque minerals

They constitute high percent of heavy minerals that ranges from 23.4 % to 40.25 %. The higher concentrations are located in the eroded beach and in the sand dunes of EL-Burg and Baltim(Table. 3 and Figs. 4 and 5). They are studied as a single group, they are composed mostly of magnetite and ilmenite, while hematite and limonite are rare.

2- Non-opaque minerals

They constitute the main bulk of heavy minerals of the study area. They are composed mainly of augite, hornblende, zircon, epidote, garnet, tourmaline , monazite and others.

Augite

Augite is the most common non-opaque heavy minerals in the study samples. It is recorded in all the investigated samples, but it is recorded in high percentages in the right international road and the beach of study area (Table. 3 and Figs. 4 and 5). Its color varies from greenish yellow to brownish violet. Most of the augite grains are short prismatic or irregular with frequent rounded grains.

Hornblende

It varies in color from glassy green, bluish green to rare brownish green. The grains are usually prismatic, angular to subrounded. It is recorded in high percentages in the beach of the study area (Table.3 and Figs. 4 and 5).

Zircon

The higher percentages of zircon is recorded in the erosional areas and in the sand dunes of El-Burg and Baltim (Table.3 and Figs. 4 and 5). Zircon is mostly represented by small prismatic grains with rounded edges. The zircon grains are mostly colorless but vary from water clear to dusky turbid.

Epidote

It is recorded in high percentages in the beach of the study area (Table. 3 and Figs. 4 and 5). Epidote is recorded as lemon yellow and greenish yellow color with rounded to subrounded grains. Some grains exhibit week pleochroism with high relief.

Garnet

The higher percentages recorded in the erosional areas and in the sand dunes of El- Borg and Baltim (Table. 3 and Fig. 4 and 5). Garnet occurs in subangular to subrounded and rounded grains. It is represented by colorless to pink varieties. Garnet grains have a very high relief and it is isotropic under crossed nicols.

Rutile

It is recorded mainly in the erosional areas and in the dunes of EL-Burg with high concentration and recorded with lower concentration in the beach (Table. 3 and Fig. 4 and 5). Rutile is observed in reddish brown and yellowish brown varieties, where the reddish brown is the most common. Rutile is observed as minute prismatic grains mostly with rounded edges.

Tourmaline

It is recorded in low percentage in the erosional areas and in EL-Burg and Baltim dunes and approximately high percent in the beach of the study area (Table. 3 and Figs. 4 and 5). It is observed as egg shaped and display different colors but the brown variety with strong pleochrism is common.

Monazite

Monazite grains are very rare, it is recorded in low amount in the erosional areas and EL-Burg and Baltimdunes (Table. 3 and Fig. 4 and 5).. They are rounded to oval shape, with lemon yellow and green color. The grains have a very high relief.

Table. (2): Mineralogical analysis of the samples of the area between Burg EL-Burullus and Baltim

Minerals	**Samples**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Opaque	35.9	39.6	44.1	38.8	33.2	46.3	42.7	23.4	37.6	30.9	34.3
Non Opaque	64.1	60.4	55.9	61.2	66.8	53.7	57.3	76.6	62.4	69.1	65.7
Amphipole (Horn.)	22.5	23.1	23.3	17.9	23.3	17.7	30.2	28	21.3	25.1	27.6
Pyroxene (Aug.)	14.7	13.5	13.6	13.5	15.5	8.5	17.4	25.4	15.2	17.6	13.6
Epidot	15.9	16.2	16.1	17.8	15.7	15.3	14.8	13	15.9	18.2	16.1
Zircon	19.4	19.2	22.1	22.9	18.1	21.2	19.5	14.9	19.2	16.7	18.3
Tourmaline	4.3	5.1	6	4.8	4.1	6.5	2.7	2.1	3.7	3.4	2.9
Rutile	12.9	11.2	12.2	14.6	11.7	14.1	9.4	9.9	11.8	12.6	10.7
Garnet	5.2	5.9	8.1	6.8	5.2	9.4	4.5	3.8	6.6	3.5	6.8
Monazite	3.9	4.1	4.2	5.3	3.6	5.3	2.8	2.1	4.7	2.3	3.6
Others (staulite+biotite)	1.1	1.2	1.2	1.4	1	1.2	1.2	0.9	1.1	0.6	0.4
Heavy fraction	70.2	73.8	80.2	90.4	73.5	81.7	65.8	52.3	79.7	81.2	60.9
Light fraction	29.8	26.2	19.8	9.6	26.5	18.3	45.2	47.7	20.3	18.8	39.1
Op/nonopaq.	0.56	0.65	0.79	0.63	0.5	0.86	0.36	0.31	0.6	0.45	0.52

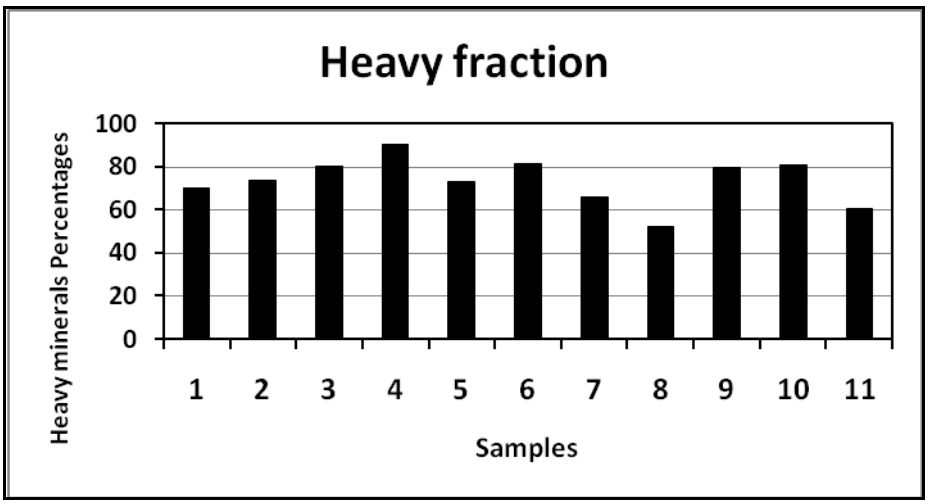

Fig. (3): Heavy fractions percentages in the study area

Table. (3): Percentages of the heavy minerals species in the different locations in the study area

Lift of international Road	Average percentages of eroded east Baltimbeach	Right of international Road	Average percentage of Burg EL-Burullus dunes	Average percentages of Burg EL-Burullus eroded beach	Minerals
60.9	80.45	52.3	77.85	74.73	**Heavy percentages**
34.3	34.25	23.4	40.25	39.86	**Opaques**
27.6	23.2	28	22.27	22.96	**Amphibole (Hornblende)**
13.6	16.4	25.4	13.72	13.93	**Pyroxene (Augite)**
16.1	17.05	13	15.9	16.06	**Epidote**
18.3	17.95	14.9	20.42	20.23	**Zircon**
2.9	3.55	2.1	4.52	5.13	**Tourmaline**
10.7	12.2	9.9	12.45	12.1	**Rutile**
6.8	5.05	3.8	6.47	6.4	**Garnet**
3.6	3.5	2.1	4.25	4.06	**Monazite**
0.4	0.85	0.9	1.2	1.16	**Others (Staurolite +Biotite)**

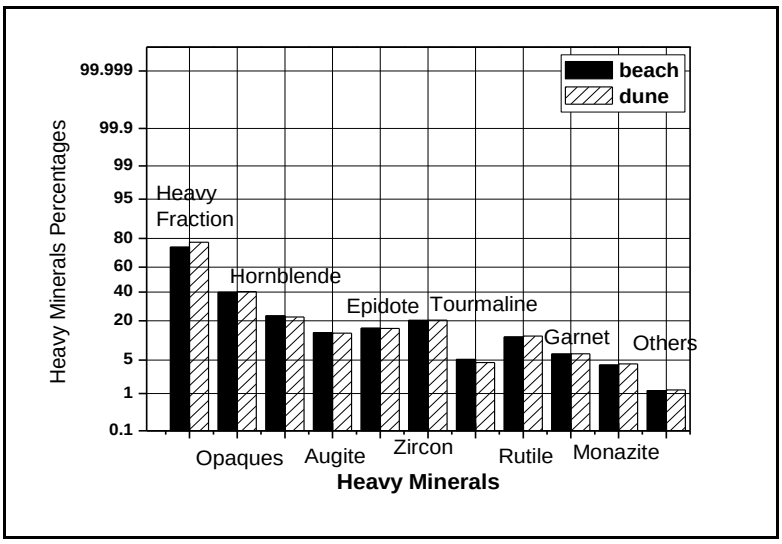

Fig. (4): Heavy minerals in the dunes and beach of Burg EL-Burullus area

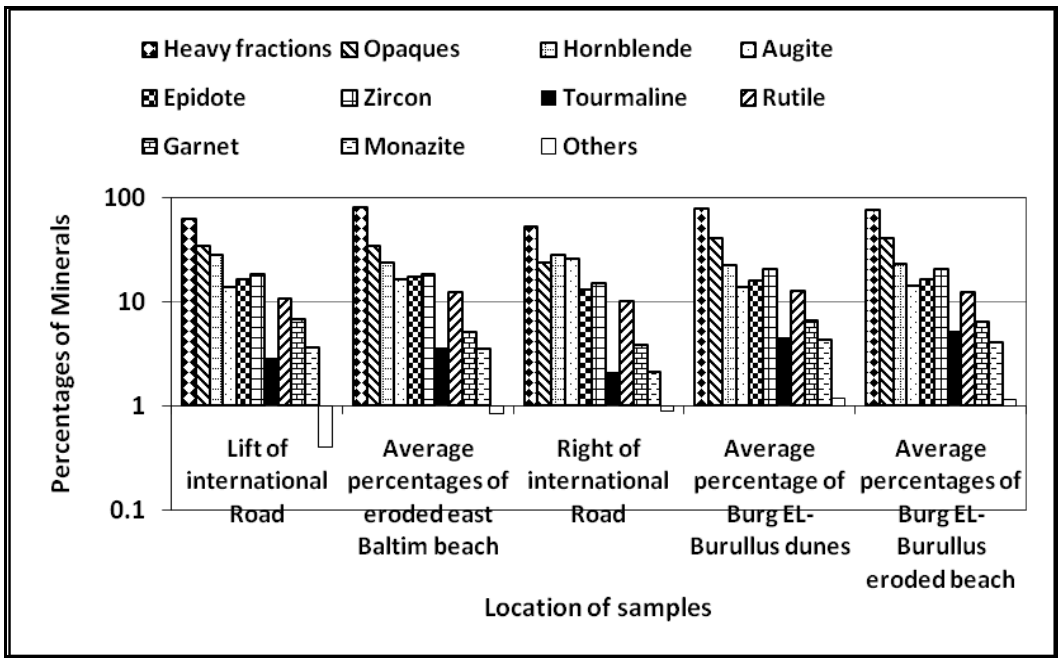

Fig.(5): Changes of heavy minerals species in the five location between Burg EL-Burullus and Baltim

Conclusions

The total heavy minerals increase from shoreline moving to the crest of dunes and they are higher in top and lee side of dune than bottom and stoss side of dune. The heavy mineral variations normal to the shoreline show that the opaques, garnet, rutile, zircon and monazite markedly increase while hornblende, augite, tourmaline, and epidote decrease in moving from the beach to the dunes. The total heavy minerals of shoreline and backshore of east Baltim resort are higher than that in the EL-Burg shoreline and backshore.

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