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CORRELATION BETWEEN COASTAL SEDIMENTS ALONG BURULLUS — DAMIETTA STRETCH, EGYPT

N. M. EL-FISHAWI

Geology Dept., Institute of Coastal Research*

ABSTRACT

The most conspicuous physiographic features of Egypt are the Nile Valley and the Nile Delta coast. The present study investigates the relationship between the coastal environments of the Nile Delta. The area of study lies between longitudes 30° 55' and 31° 52' E. It extends for about 87 km along the coast between Burullus and Damietta mouth. The coastal area could be subdivided into 5 environments according to the geomorphology and the nature of sediments. Coastal dunes, backshore, beach, breaker and nearshore are well developed here and extend in narrow strips up and down the length of the coast.

The coastal sediments are evaluated depending upon:
1. Mean grain size statistical parameter.
2. Correlation coefficient of mean grain size.
3. Shape measurement for sand grains (roundness value).
4. Number frequency for some species of heavy minerals.

The sediment characteristics of the coastal environments indicated strong relationship normal to the shoreline in moving from littoral to eolian environments. The dynamic forces effecting the coast play an effective role in sorting processes within each coastal environment.

INTRODUCTION

Sedimentary petrographers have attempted to use grain size determine sedimentary environments. A survey of the extensive literature on this subject illustrate the steady progress that has been made toward this goal. Many excellent contributions have been made, each providing new approaches and insights into the nature and significance of grain size distributions such as bivarian plot technique (MASON and FOLK 1958; FRIEDMAN 1967; MOIOLA and WEISER 1968; GINDY *et al.* 1982), log-probability curve technique (FULLER 1961; SPENCER 1963; VISHER 1969) and CM diagram technique (PASSEGA 1964).

One of the major problems in distinction between environments is that the same sedimentary processes occur within a number of environments and the consequent textural response is similar. In fact, the textural studies do not need to stand alone, but can provide a separate line of evidence to aid in identifying sedimentary environments.

The aim of the present study, therefore, is to determine quantitatively the same properties occur within the coastal sedimentary environments. Grain size, roundness and heavy minerals were used to investigate the relationship normal to the shoreline.

* 15 Faraana St., Alexandria 21514, Egypt

SAMPLING AND TECHNIQUES

The area under investigation lies between longitudes 30° 55' and 31° 52' E (*Fig. 1*). It extends for about 87 km along the eastern coast of the Nile Delta between Burullus outlet and Damietta mouth. During April 1980, the coast was surveyed and samples were collected at 3 km intervals. The sample net consisted of 28 transects at right angles to the coast. Each profile contained samples from coastal dune, backshore, beach, breaker and nearshore (6 m depth).

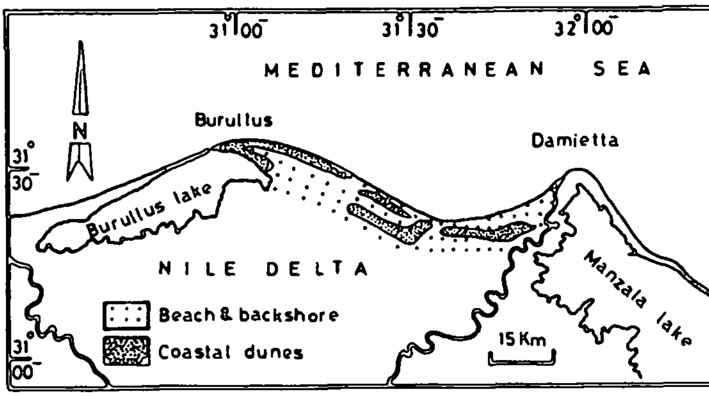

Fig. 1. Location map for the studied area.

Grain size analysis was carried out by the conventional sieving method with screens placed at one-phi intervals. About 50 g of sands was taken for analysis, using a mechanical shaker with a sieving time of 15 minutes. The sieve meshes give the class intervals -1, 0, 1, 2, 3, and 5 phi. Mean grain size proposed by FOLK and WARD (1957) was then obtained by using a suitable computer programme.

Quantitative expression of grain shape was used. BOGGS (1967) describes the use of grain photographs and the Zeiss electronic particle size analyzer (Zeiss TGZ 3) in the analysis of grain roundness. The roundness values of the present investigation were calculated according to this technique on grain sizes between -1 and 5 phi. About 100 grain photographs for each sample were used.

Fractions lying between 2 and 4 phi were used for heavy mineral study. The heavy minerals were separated by using the well-known bromoform separation technique. About 400 grains were counted in Canada Balsam for each sample. Number frequency was obtained for opaque, amphibole, pyroxene, zircon, tourmaline and rutile.

RELATIONSHIP BETWEEN COASTAL ENVIRONMENTS

The coastal area between Burullus and Damietta was chosen as a testing ground to determine the relationship among coastal sands of various environments. It represents 5 environments according to the geomorphology and the nature of the sediments. Coastal dunes, backshore, beach, breaker and nearshore are well developed here. All the coastal environments are normally sharply distinguished and extend in narrow strips up and down the length of the coast.

Mean grain size, roundness and heavy minerals for each environmental sands were averaged to represent a single profile in order to trace the variation normal to the shoreline.

Mean grain size:

The investigation of the data can be made by plotting the mean grain size with each environment normal to the shoreline (*Fig.* 2). A visual inspection of the mean size can be used as a preliminary interpretation of the energy conditions within each environment. It is generally true that the grain is coarser where the energy is greater.

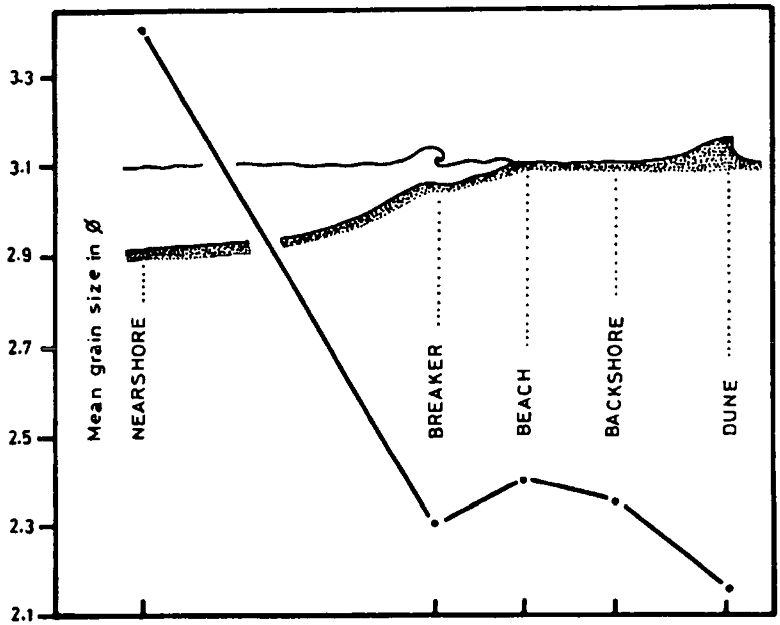

Fig. 2. Mean grain size relationships for coastal environments.

Finest mean grain size is occurred at the nearshore sediments. The mean size of 3.4 Φ indicates quite energy conditions up to 6 meter depth. In moving from the nearshore through the breaker to the beach, there is steady increase in the mean size. Mean grain size of 2.3 Φ shows a high energy levels where the waves break. Beach sediments become slightly finer (2.4 Φ) than the breaker sediments due to decreasing energy. On the other hand, backshore and dune sediments subject to the wind action. The mean grain size becomes coarser in moving from the beach through the backshore (2.35 Φ) and up to the dune (2.15 Φ). The wind action tends to select the coarser grains from the beach to be added to the backshore and dune sediments. So, it can be said that the energy conditions and levels play an effective role in relating the mean grain size to each coastal environment.

Correlation coefficient

EL-FISHAWI (1983) calculated the correlation coefficient of the mean grain size for each pair of some coastal sands. In the present investigation, this correlation coefficient is analysed after adding that of the nearhore sands. The correlation coefficient is calculated to measure the correspondence of the mean size to the fitted equation.

The relationship between coastal environments depends upon the presence of agreement or disagreement between adjacent or not adjacent environments which can be reflected from the value of the correlation coefficient. The sketch diagram in *Fig. 3* illustrates the results.

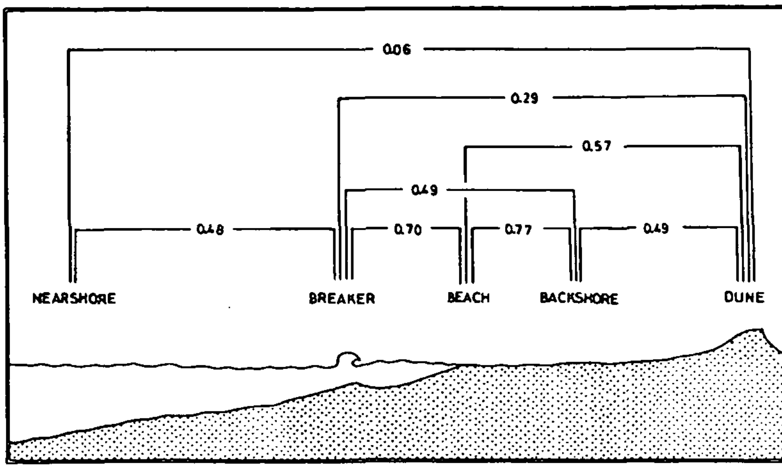

Fig. 3. Correlation coefficient relationships between each pair of mean grain size for coastal sands.

The correlation coefficient of the mean grain size for each pair of coastal environments provides a general view about the nature of the relationship. A relatively significant correlation coefficient is found between the adjacent environments; it ranges from 0.70 to 0.77 for the relations beach-breaker and beach-backshore. Insignificant correlation is appeared for the backshore-dune relation. In fact, the backshore is normally flooded with sea water. A distance of about 800—1000 m separating breaker from nearshore may explain the insignificient correlation between them. On the other hand, the relationship between each pair of separated environments is often weak; the correlation coefficient for the breaker-dune, breaker-backshore and beach-dune relations ranges from 0.29 to 0.57. At last, there is no relationship between nearshore and dune environments (r= 0.06) where the dynamic forces effecting them are totally different.

Grain shape:

Definite correlation between roundness and coastal environmental sands is established (*Fig. 4*). The line connecting the mean roundness for each environment indicates a marked increase in roundness in moving from nearshore (0.36) through breaker (0.45), beach (0.50), backshore (0.52) and up to dune sands (0.58).

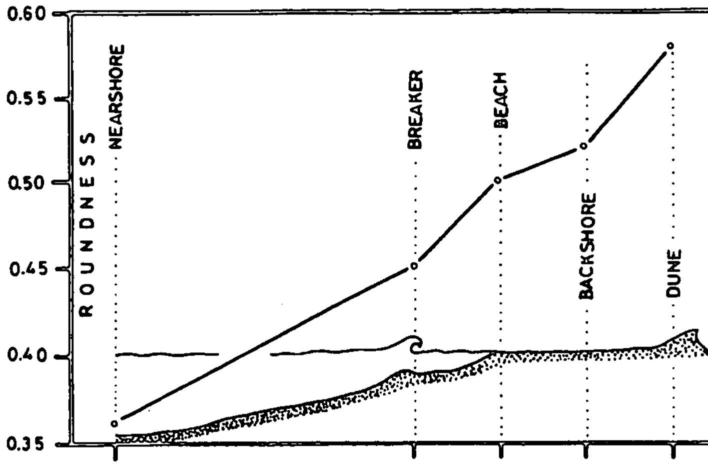

Fig. 4. Roundness variations normal to the shoreline.

Higher roundness in beach sands than in both nearshore and breaker sands may be due to the action of waves and swash in selecting the more rounded grains to be added to the beach. On the other hand, the improvement of roundness from the beach to the eolian sands may be related to the sorting processes of the wind action. The wind can select the more rounded grains from the beach to be rolled and finally added to the dune sands. Therefore, during the sediment transport normal to the shoreline, dynamic forces tend to sort the grains according to their shape. Moreover, it can be simply stated that the eolian action is more effective in shape-sorting processes than the wave action where the dune sands are rounder than the littoral sands.

Heavy minerals:

Number frequency for opaques, amphiboles, pyroxenes and zircon + tourmaline + rutile (ZTR) was examined as shown in *Fig. 5*. It is interesting to note that the number frequencies for opaques and amphiboles are inversely related to each other; as the opaques increase, the amphiboles decrease.

In moving from the nearshore landwards, opaque frequency decreases from 26.18 % to 14.49 % at the breaker and then increases with fluctuations to the beach (23.88 %), the backshore (18.06 %) and up to the dune (28.62 %). At the same direction, amphiboles and pyroxenes show inverse relation. Number frequency for zircon + tourmaline + rutile indicates a progressive increase from the nearshore (0.46 %) through the breaker (0.76 %), the beach (4.64 %), the backshore (1.77 %) and up to the dune (3.53 %).

High amphibole and low opaque contents at the breaker sands may be related to the action of breakers in concentrating the less heavies with the coarse sand. Wind action plays an effective role in concentrating the more heavies in dune sand. Lower content of amphibole and higher content opaque and ZTR in the eolian than in the littoral sands may be related to the fact that the wind working over the dunes more than the beaches; where wetness prevents much wind action.

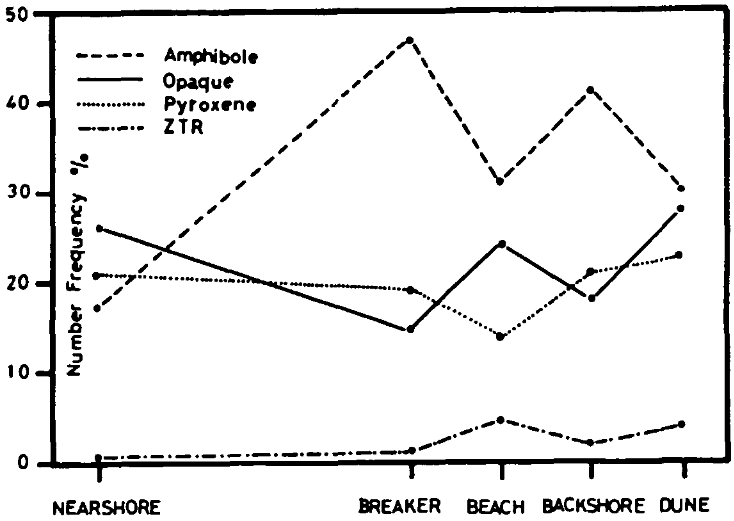

Fig. 5. Heavy mineral variations normal to the shoreline.

CONCLUSIONS

The sedimentary environments of the Nile Delta coasts display a strong correlation normal to the shoreline. The results of the mean grain size, roundness and heavy minerals analyses indicate a significant trend in moving from the littoral environments (nearshore, breaker and beach) to the eolian ones (backshore and dune). In moving from nearshore through breaker, beach, backshore and up to dune environments, it was found:

1. A progressive increase in mean grain size.
2. A strong relationship between each pair of adjacent environments and weak or no relationship between the separated environments.
3. A marked improvement of roundness value.
4. An increase of opaque and zircon + tournaline + rutile and a decrease in amphibole with some fluctuations.

Wave and surf actions in the littoral environments tend to select the coarser, the rounder and the heaviest mineral grains to be added to the beach. On the other hand, wind action in the eolian environments usually continue the sorting processes up to the sand dunes which contain the coarsest grains, the highest roundness value and high concentration of the heaviest minerals. Eolian action is more effective in sorting processes than the littoral action.

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