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A TEXTURAL STUDY OF NEARSHORE RECENT SEDIMENTS, MAKRAN COAST, PAKISTAN

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Recent sediments, accumulating along Makran coast, at ten meter isobath, are terrigenous, low calcareous, silt dominated and of fluvial and eolian origin. They are generally poorly sorted and invariably positively skewed. Clear patterns of sorting characters, along the length of the coast, did not emerge from the present study, partly due to insufficient number of analyses and partly obscured by local variations.

Key words: Marine, Sediments, Makran coast, Texture.

INTRODUCTION

It is increasingly important to know the characteristics of the coastal and offshore sediments for a meaningful exploration of the territorial sea of Pakistan. Reconnaissance geophysical surveys have been carried out in Makran offshore by oil companies which provide deep penetration stratigraphic data but sediment characterization remains only of limited and generalized nature. The deep sea drilling project provides some sedimentological data [1], but even the nearest offshore study site is several hundred kilometers away from the Pakistan coastline.

This paper examines the grain size and sorting characters of nearshore sediments, accumulating at the ten meter isobath along the Makran coast, from Gadani to Pasni (Fig. 1). Further data collection is planned from full length of the coastline upto Gawadar and from the whole width of the continental shelf extending up to 40 kilometers seaward. This will constitute a sedimentological data base of Makran present-day shelf sediments.

MAKRAN SUBDUCTION ZONE

Pakistan has a coastline of 1,120 kilometers divisible into Indus cone and Makran Coast. Makran coast runs east-west from Sonmiani bay to Gawadar within Pakistan and continues up to the Strait of Hormuz in Iran. The Makran continental shelf, measured offshore to a depth of 130 meters is rather narrow at 25 to 45 kilometer in width as compared to usual shelf width of 70 kilometers. The coastal plain is an equally narrow belt, 30 to 40 kilometers landward, followed by Southern Makran ranges. The sedimentation rates are thus expected to be high with abundant supply of fluvial and eolian terrigenous material.

The Makran region represents an area of ocean-continent lithospheric collision. It has been interpreted as an accretionary wedge formed on the hanging wall of a shallow subduction zone where subduction is an ongoing process [2]. However, no physiographic trench is present in Makran offshore nor are typical trench and slope deposits found [3], though a sediment filled trench is confirmed by seismic reflection profiles [4]. Modern nearshore sedimentation is analogous to the processes that have operated during Neogene. A study of recent sediments, accumulating at shoreline, continental shelf or slope, therefore, provides an insight into the characterstics of older sediments, marine or subaerial.

Procedures. Fiftysix samples were collected from Gadani to Pasni on two cruises of naval survey vessel "Bahr-e--Paima" (Fig. 1). The cruise followed the coastline along ten meter isobath. The samples were collected by Patterson grab sampler from the water sediment interface. The samples were collected from stations at about 10 kilometer interval, 5 to 10 kilometer away from shoreline. In the first phase 23 samples have been selected for detailed textural studies. The remaining samples are being analysed and will be reported later.

All samples were dried in an oven for 24 hours at 60°. For grain size analysis 10 g. of the sample were prepared by coning and quartering. For complete separation of particles, 2 ml of 10 % calgon in 200 ml of water, was added to the samples. The samples were then subjected to wet sieving which separated particles of 0.038 mm size and larger. The fraction smaller than 0.038 mm was analysed by settling velocity and separation was carried out up to 0.00195 mm or about 2 micron size.

Composition of the sediments. The sediments, off Makran coast, are mostly silt and mud with a sandy fraction between 1 to 2 %. However, some samples can be classified

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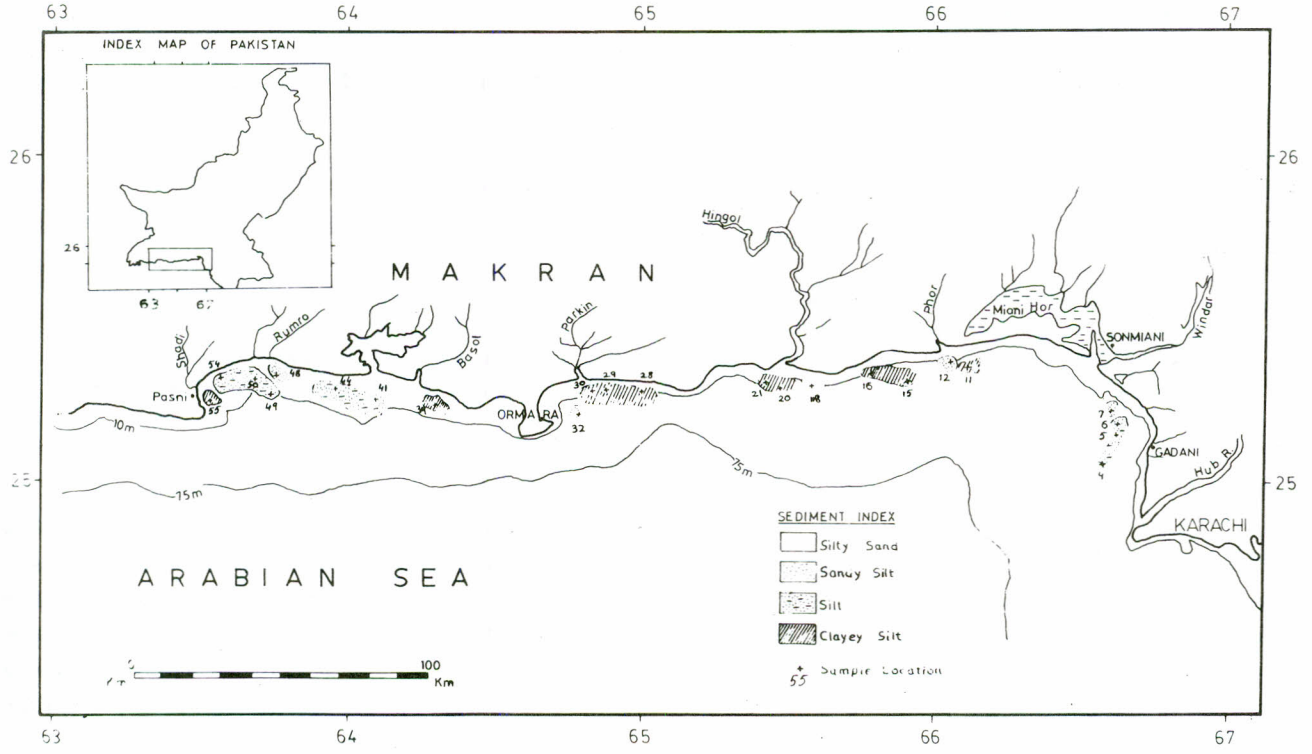

Fig. 1. Map of Makran Coastal sediments.

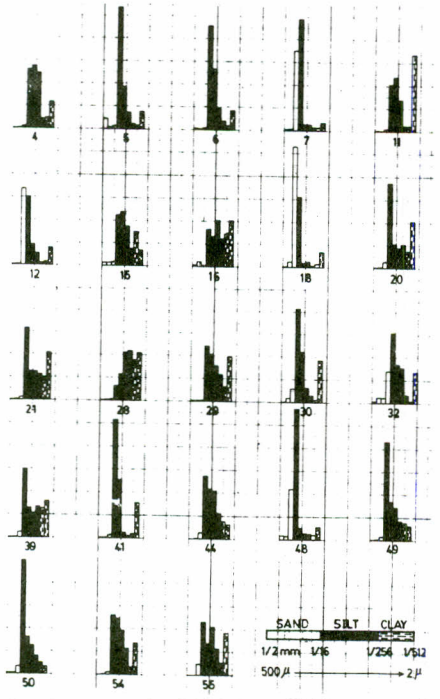

Fig. 2. Histograms for 23 Makran off shore samples.

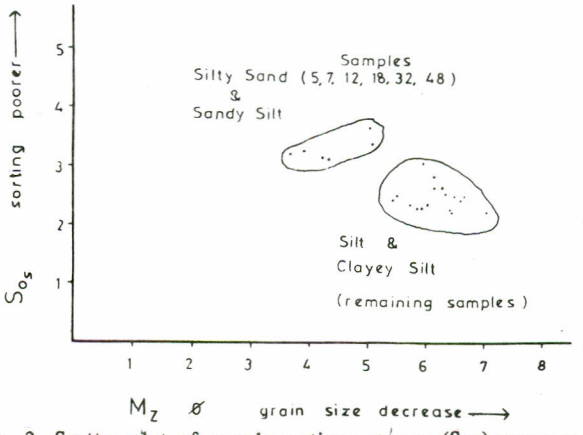

Fig. 3. Scatter plot of sample sorting measure (Sos) versus mean grain size (Mz).

as sandy silt and one of them is a silty sand. In general, these are terrigenous, low calcareous, silt dominated sediments with quartz as a major mineral component. They are invariably gray coloured. The results of grain size analysis are presented as histograms (Fig. 2). It is possible to divide the belt of nearshore sediments in three units viz: a silty stretch near Gadani, another one near Pasni and the intervening stretch from Sonmiani to Ormara is comprised of mud. The mud is mostly clayey silt. But there are patches of sandy silt and even silty sand at the mouth of rivers where sediment load is discharged into the sea.

Mean grain size and mode. The graphic mean (Mz) of the sediments range from 3.6 ϕ to 7 ϕ (0.08 mm to 0.008 mm). The graphic mean of Gadani silt is 5.3 ϕ to 5.9 ϕ and that of Pasni silt 5.2 ϕ to 5.4 ϕ. Thus, it can be said that Gadani silt is slightly coarser than Pasni silt. A look at the histograms will show that one size-class is more prominant than all the other classes, that is, the distribution is

unimodal as in samples 49 and 50. There are more than one modal class in rest of the samples and these can be termed as polymodal. It is interesting to note that the two silt stretches differ in this respect rather distinctly. The Gadani silts are polymodal while Pasni silts are often unimodal or bimodal.

Sorting. The sorting of sediments, as measured by ϕ standard deviation (σ_1), falls between 1 and 2. All samples, therefore, can be classed as poorly sorted. There is, however, one sample, a bimodal silt near Pasni, which is very well sorted with a ϕ measure of 0.22. It is difficult to explain, at this stage, why a single sample is so well sorted among all poorly sorted samples. There is no overall difference in sorting of silts from Gadani and Pasni.

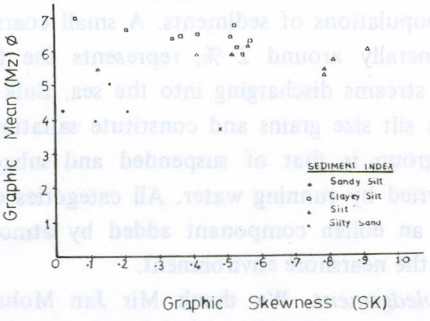

Fig. 4. Scatter plot of skewness (SK) versus mean grain size (Mz).

Skewness. All analysed sediments were found to be positively skewed, having a long spread of fine fractions. In some samples the skewness is only slight and they can be called nearly symmetrical; other samples are strongly skewed. Gadani and Pasni silts do not differ in skewness. It is, however, important to note that despite wide range of values, a negative skewness was not observed.

Kurtosis. A wide range of kurtosis values was obtained for the analysed sediments. The sediments were found to be very platykurtic to exteremely leptokurtic. The finer sediments i.e. most clayey silts are platykurtic while silts with sandy fraction are leptokurtic.

Interrelationships between parameters. Interrelationships between several parameters were investigated but clear patterns did not emerge. This is partly due to insufficient

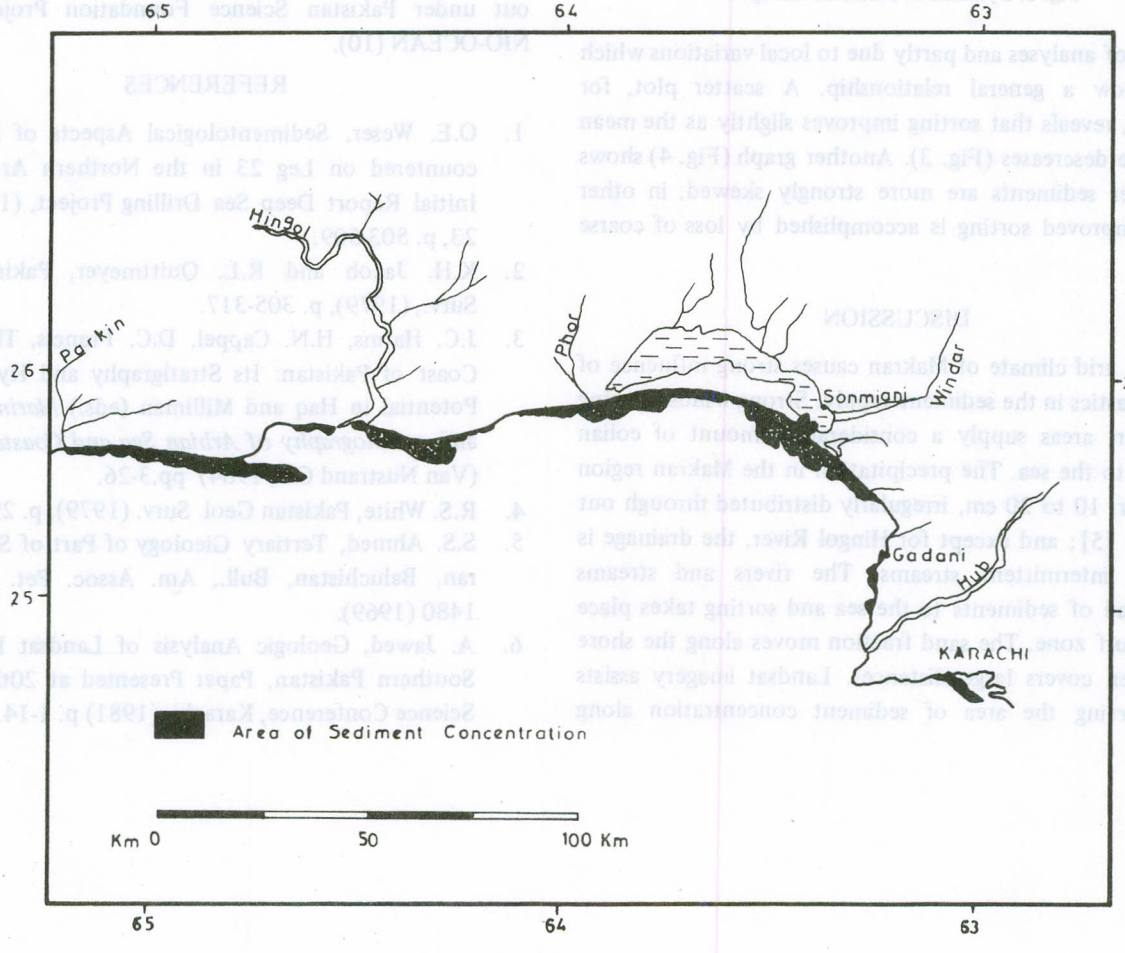

Fig. 5. Marine turbidity along Makran coast.

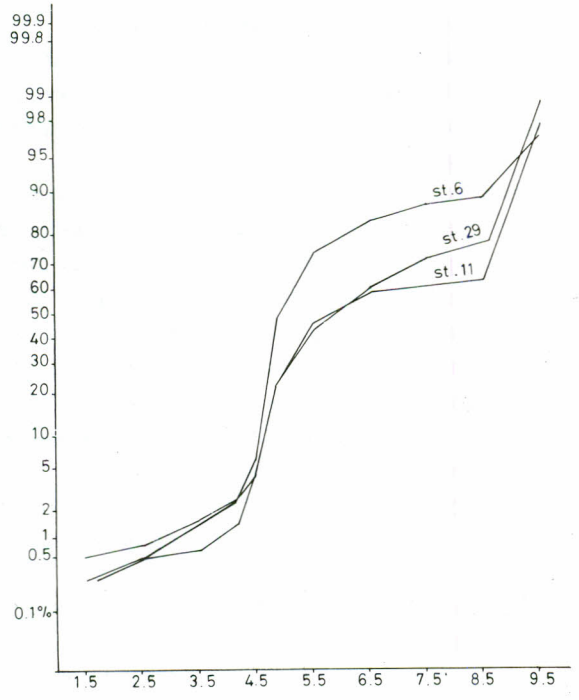

Fig. 6. Dynamic of sediment transport.

number of analyses and partly due to local variations which overshadow a general relationship. A scatter plot, for example, reveals that sorting improves slightly as the mean grain size descreases (Fig. 3). Another graph (Fig. 4) shows that finer sediments are more strongly skewed; in other words improved sorting is accomplished by loss of coarse grains.

DISCUSSION

The arid climate of Makran causes strong influence of eolian clastics in the sediment supply. Strong winds blowing off desert areas supply a considerable amount of eolian detritus to the sea. The precipitation in the Makran region is meager, 10 to 20 cm, irregularly distributed through out the year [5]; and except for Hingol River, the drainage is through intermittent streams. The rivers and streams carry load of sediments to the sea and sorting takes place in the surf zone. The sand fraction moves along the shore and often covers large distances. Landsat imagery assists in observing the area of sediment concentration along Makran coast (Fig. 5) [6]. The silt and clay fractions are carried offshore in the deeper water by currents. This separation is discernible in our scatter plots, though in a very subdued manner. The sediments with sand fraction show a poor sorting measure, high skewness and sharp peakedness; the sediments with clay and silt size particles only, show slightly better sorting, low skewness and are platykurtic.

The grain size analyses have also been plotted on probability paper (Fig. 6). Each graph is readily divisible into three populations of sediments. A small coarse grain fraction, generally around 2 %, represents the traction load of the streams discharging into the sea. Bulk of the sediments is silt size grains and constitute saltation load. The third group is that of suspended and subcolloidal particles carried by running water. All categories of sediments have an eolian componant added by atmospheric transport to the nearshore environment.

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REFERENCES

1. O.E. Weser, Sedimentological Aspects of Strata Encountered on Leg 23 in the Northern Arabian Sea, Initial Report Deep Sea Drilling Project, (1972), Vol. 23, p. 503-509.
2. K.H. Jacob and R.L. Quittmeyer, Pakistan Geol. Surv., (1979), p. 305-317.
3. J.C. Harms, H.N. Cappel, D.C. Francis, The Makran Coast of Pakistan: Its Stratigraphy and Hydrocarbon Potential in Haq and Milliman (eds.) *Marine Geology* and *oceanography of Arbian Sea and Coastal Pakistan* (Van Nustrand Co., 1984)' pp.3-26.
4. R.S. White, Pakistan Geol. Surv. (1979), p. 295-304.
5. S.S. Ahmed, Tertiary Gieology of Part of South Makran, Baluchistan, Bull., Am. Assoc. Pet. Goel, **53**, 1480 (1969).
6. A. Jawed, Geologic Analysis of Landsat Imagery of Southern Pakistan, Paper Presented at 20th National Science Conference, Karachi, (1981) p. 1-14.