MAHASAGAR
Vol.21, No.4 (December), 1988, pp.209-217

TEXTURE AND MINERALOGY OF BEACH SANDS OF THE NORTHERN PART OF KERALA COAST

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ABSTRACT

The provenance of beach sands is determined on the basis of correlation of textural parameters, presence or absence of individual minerals and the abundance of common mineral components. Texture and mineralogy of the beach sands of the northern part of Kerala coast has been studied. Texturally, the samples are mainly polymodal, medium to fine sand class, negatively skewed and platykurtic to mesokurtic. It is concluded that the provenance is mainly allogenic and the contribution is by rivers.

Key-words: Texture, mineralogy, beach sands, Kerala coast.

INTRODUCTION

The beach sands of Kerala coast is well known for its richness in the strategically important minerals like rutile, ilmenite, monazite, zircon. Due to comparatively lesser and non-uniform concentration of these minerals, the sands of the northern part of Kerala remains unexplored. Knowledge of provenance and concentration would help exploration of these resources.

The paper examines the provenance of the beach sands in the northern part of Kerala coast (Fig.1). The investigation encompasses the mineralogy of the beach sands as well as the correlation of its textural parameters.

Physiographically, Kerala is divided into the high lands forming part of the Western Ghats in the east followed westward by slightly undulating midland, and the low lying coastal tract along the western border. The climate is tropical with maximum rainfall during south west monsoon. A number of small streams or rivers flow down from the Western Ghats and debouch into the Arabian Sea.

MATERIAL AND METHODS

Samples were collected by penetrating a PVC pipe a few inches of sediment layer during June-July, 1985. The methods followed for textural studies have already been described in details by various authors (Folk and Ward, 1957; Mason and Folk, 1958; Friedman, 1962, 1967). The relationship between the mean size, sorting coefficient and skewness are checked

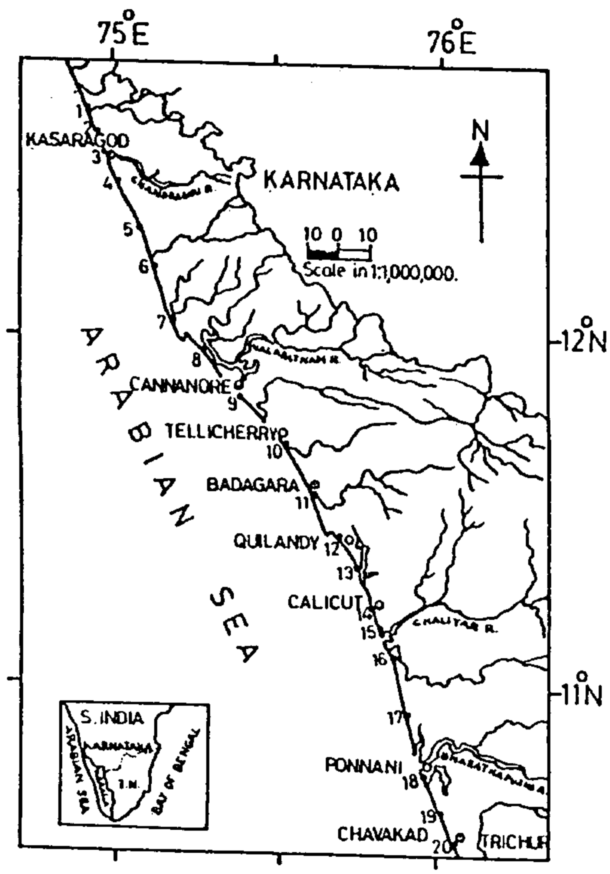

Fig.1. Location map of the study area showing sampling stations.

by correlation and regression analyses. The mineralogical investigation is carried out as per Van Andel (1950) and Poole (1958). The size fraction employed for this study ranged between 2.0 and 2.5 ϕ. The mineralogical study is restricted to the heavy fraction as they are quite sensitive in indicating the provenance of modern sands (Pettijohn, 1941; Morton, 1985). The analysis include only the non-opaque minerals. About 300 grains were counted for each sample. Small percentage variations and the absence or presence of low frequency minerals have no significance because of limitations of mineral count (Dryden, 1931; Muller, 1943; Van Andel, 1950) and the restricted size range of the sands studied (Van Andel and Poole, 1960).

RESULTS AND DISCUSSION

Texture: The beach sands in the area are bimodal to polymodal in nature. Sands of the low water zone are more of polymodal nature. The high and mid water zones are more fine grained compared to the low water zone sands. The mean size of the samples generally increased towards north in the area. The coefficient of sorting varied from 0.40 to 1.16 for the samples from low water zone, falling within the moderately well sorted to poorly sorted group. The samples from midwater and high water zones are well sorted (Table I).

In general, samples are negatively skewed and mesokurtic to platykurtic with values clustered around 0.85 and 1.10. However 30% of the low water zone and 8% of the high water zone sands skew positively (Fig.2). Mid water zone samples are negatively skewed. The representative plots show relationship between mean size and sorting coefficient (Fig.3) and mean size versus skewness (Fig.4). It appears that the mid water zone sands are more clustered in the plots than the other two.

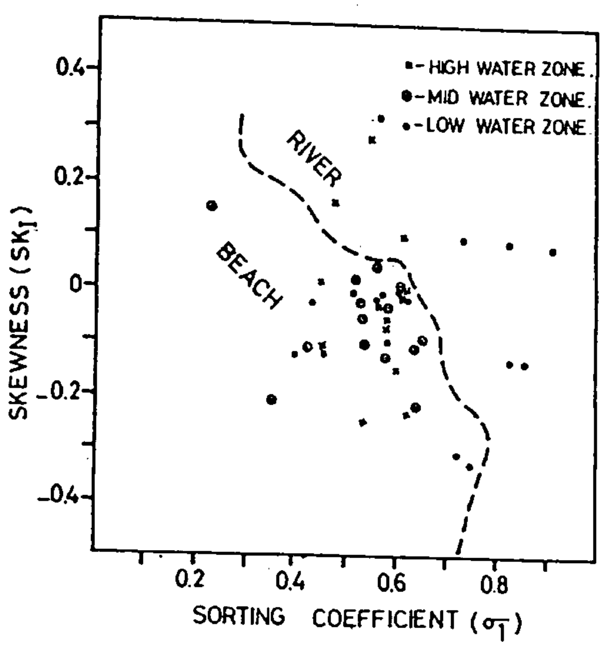

Fig.2. Plot of sorting coefficient versus skewness distinguishing beach and river sands (after Friedman, 1967).

The relationship between mean size and sorting coefficient is investigated by estimating the correlation coefficients (Table II). The mid water and high water zone sands showed negative correlation and are significant at 0.05 and 0.1% levels respectively. It establishes that the sorting increases with decrease in the size of sand for the mid water and the high water zones. The relationship between mean size and skewness reveals that the grains coarser than 2 have tendency to skew positively.

Minerals: Weight percentages of heavy minerals show considerable variation between individual samples. It ranges from 2.20 to 47.74% in the beach in between the river mouths and it is high upto 90.79% at the mouth of the rivers. Within the study area the mineralogical composition of individual samples vary considerably because of the multiple source of derivation, different energy of the transporting and depositing medium

Table I – Textural parameters of sand sediments

Samples	Graphic mean Mz (ϕ)			Inclusive graphic SD (ϕ)			Inclusive graphic skewness (Sk_1)			Graphic Kurtoses (KG)		
	LWZ	MWZ	HWZ	LWZ	MWZ	HWZ	LWZ	MWZ	HWZ	LWZ	MWZ	HWZ
1.	1.14	1.41	1.85	0.75	0.58	0.48	-0.33	-0.12	0.17	0.39	1.40	1.04
2.	1.59	1.93		0.85	0.05		-0.12	-0.35		1.10	1.04	
3.	2.12	2.08		0.56	0.60		-0.07	0.05		0.92	0.87	
4.	1.92	2.146	2.18	0.58	0.53	0.54	-0.05	-0.01	0.29	0.85	0.98	0.74
5.	1.84			0.72			0.10			0.98		
6.	2.06	2.15		0.60	0.52		0.01	-0.05		0.92	1.00	
7.		2.04	2.00		0.43	0.60		-0.18	-0.14		0.91	0.90
8.	2.11	2.256	1.98	0.45	0.64	0.65	-0.91	-0.21	0.12	0.85	0.92	0.99
9.	1.68			0.62			0.03			1.00		
10.	1.81			1.16			0.07			0.89		
11.	2.01		1.85	0.40			-0.12			0.93		
12.	1.88			0.43			-0.02			1.11		
13.	1.28	2.00	1.66	0.82	0.60	0.58	-0.13	0.01	-0.35	0.71	1.12	0.82
14.		2.85	2.65		0.36	0.44		-0.20	0.02		1.11	1.68
15.	2.18	2.47	2.26	0.59	0.54	0.53	0.35	-0.19	-0.24	1.14	1.32	1.10
16.	1.46	2.65	2.14	0.51	0.23	0.48	-0.06	-0.16	-0.10	1.27	1.00	1.11
17.	2.14	2.04	2.18		0.58	0.62		-0.03	-0.19		0.92	0.97
18.	1.69	2.09	1.42	0.83	0.63	0.58	0.10	-0.01	-0.07	1.02	0.94	1.11
19.	1.41	1.91	1.87	0.58	0.65	0.61	-0.07	-0.09	-0.02	1.04	1.06	1.14
20.	1.39	1.65	2.23	0.93	0.51	0.62	0.08	0.03	0.01	1.02	1.13	0.88

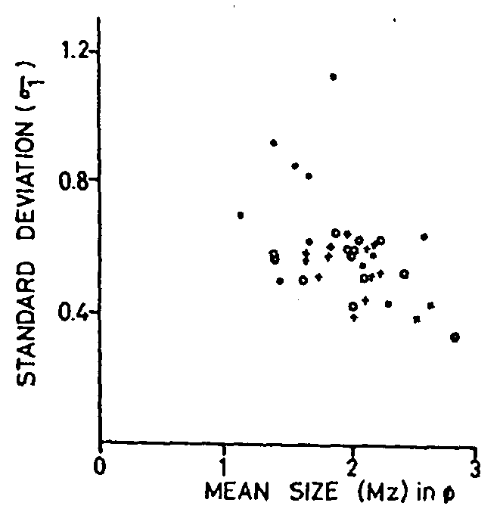

Fig.3. Relationship of mean size and standard deviation

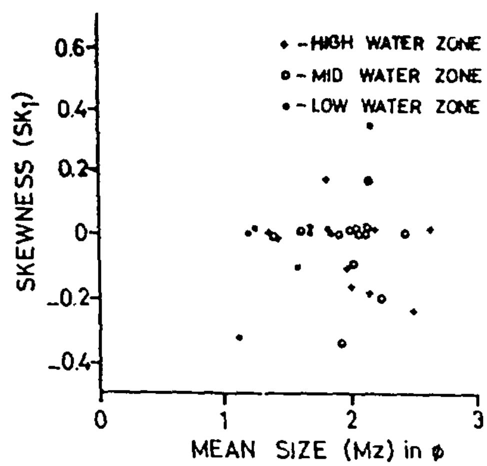

Fig.4. Relationship of mean size and skewness

and the possible mixing at the depositional sites. Some of the minerals, however, show predominance regionally. Hypersthene constitutes the dominating non-opaque heavy mineral followed by bluish green hornblende, pink garnet, common hornblende, mica clinopyroxene and a little rutile in northern part of the investigated area. Towards south the amount of bluish green hornblende and biotite increases with decrease in the concentration of hypersthene. The other minerals do not show any significant variation. The proportion of garnet is high at the mouth of the rivers and near the mouths of the rivers on the beach.

Table II — Coefficient of correlation of inclusive standard deviation (y) on graphic mean size (x) and coefficient of regression of x on y and y on x.

Location	Bxy	Byx	Correlation coefficient	Level of significance
LWZ	-0.56	-0.19	-0.3261	Not significant at 0.1
MWZ	-1.02	-0.26	-0.51	Significant (0.05)
HWZ	-0.12	2.17	-0.51	Significant (0.1)

Table III — Percentage variation of heavy minerals

Location	Weight percentage of heavy minerals		
	LWZ	MWZ	HWZ
Northern area	6.88 to 47.65	5.82 to 18.59	2.20 to 11.28
Central area	3.66 to 30.28	5.82 to 8.77	7.36 to 37.81
Southern Area	12.47 to 26.07	2.34 to 10.34	4.87 to 49.90
River mouths		65.51 to 97.90	

Table IV — Percentage variation of individual heavy minerals

Minerals	Average percentage
Opaques	5-40
Hornblende	4-77
Hypersthene	12-53
Garnet	0-45
Pyroxene	0-5
Mica	2-14
Sillimanite	0-27
Tourmaline	0-22
Rutile	0-5
Zircon	0-2
Kyanite	0-4

The size gradings along beach foreshore has been attributed to variation in wave energy along shores (Krumbein, 1944; Goldsmith, 1976), selective sorting of sediment in the direction of longshore transport (Morton, 1985), progressive loss of fine grains offshore in a down drift direction (Schalk, 1938; Mac Cave, 1978) and distance from coarse sediment sources. Generally the grain size is gradational in down drift direction. The beach sands are fine grained in the mid water and high water zones while it is coarser in low water zone. This is caused either due to washing away of fine sand or due to the addition of more coarse grained sediment from other sources and retention of them along with the fine sand sediments.

The eroded sands are normally finer and better sorted than the accreted sands. This is due to the accreted sands having foreign particles transported into the environment (Anwar, Girdy, El Askary and Fishawi, 1979). The well sorted nature of mid and high water zone sands suggests that erosion is more probable than accretion. Premchand and Harish (1985) observed intense wave energy expended on the beach and severe erosion at many parts of the coast during southwest monsoon. The incoming waves and the backwash removed the fine grained sand in suspension towards offshore during this season. The intensity of wave action is reduced during other parts of the year along with a considerable decline in supply of sediments by the rivers. A mild accretion and modification of the beach topography takes place during this period. The coarser particles from the back shore zone are carried down through rolling to give rise to high mean size value for the low water zone sands than others as observed. The low velocity of the backwash trapped the coarser sand particles in the zone.

The negative coefficient of correlation between mean size and sorting coefficient, is however, highly significant for the mid water and high water zone sands. If it is believed that multiple size grade sands are brought into the beach by the rivers the winnowing action of the waves exert better control over the sorting and deposition of the grains during the period of accretion and as a result the sands show the textural characters of beach sands (Fig.2) for the mid water and low water zones.

Bluish green hornblende is characteristic of metamorphic rocks (Van Andel and Poole, 1960). Colourless and pale pink garnets are derived from charnockite rocks (Mallik, 1981; Veerayya, Murthy and Varadachari, 1981). Hypersthene and the bluish quartz are typical of charnockitic rocks. Rutile is derived mainly from metamorphic rocks (Herz, 1976a, b; Haggerty, 1976; Force, 1979).

The minerals observed in the beach sands are bluish green hornblende, hypersthene, pink and pale pink garnets, mica and rutile which are similar to the suite of minerals identified in the river sediments. Presence of subhedral habit of the hornblende and hypersthene grains and the absence of secondary minerals like glauconite support the primary derivation of the sands. The heavy mineral association of the area under study reflect the mineral suites of Archean rocks like charnockite, hornblende and biotite gneisses, granites and khondalites of the Western Ghats.

It can be concluded that the sands on the beach are not brought in by longshore drift from offshore sources, and are not reworked from pre-existing deposits on land or on continental shelf, instead the rivers emptying into the sea contributed them to the beach.

ACKNOWLEDGEMENT

The authors are grateful to Prof. Y.L. Dora, Director, School of Marine Sciences, Cochin University of Science and Technology for providing the working facilities. The financial assistance from CSIR by way of a Senior Research Fellowship to one of the authors (KS) is greatly acknowledged.

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