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GRAIN SIZE PARAMETERS AND HEAVY MINERALS OF TILMATHI BEACH SEDIMENTS, CENTRAL WEST COAST OF INDIA

G.N. Nayak
Department of Marine Sciences and Marine Biotechnology, Goa University, Goa-403 205

ABSTRACT

Grain size study carried out on a small sheltered black sand beach, reveals that the sediments are moderately well sorted and mostly negatively skewed with mean size falling within coarse to very coarse sand class, The weight percentage of heavy minerals obtained vary from 28.76 to 42.8% beween size fractions 2.75ϕ and 4ϕ. The heavy minerals identified includes hornblende, tremolite, magnetite, ilmenite, pyroxenes and epidote. The results obtained are used to explain energy conditions and also provenance.

Key words : Grain size, Heavy minerals, Tilmathi Beach Sediments, Central West Coast of India.

Introduction

Tilmathi is a small beach on the central west coast of India situated about to km NNW of Karwar town (Fig. 1). This beach which is trending E-W, is sheltered by rocky cliff ands boulders on the north western side. The beach sediments here are black sands of very coarse grain size (Plate I).

A review of previous work (Kidwai, 1971; Veerayya, 1972; Kumar, 1977; Venkatesh and Michael, 1985; Chavadi and Nayak, 1987; Nayak, 1993 and Nayak, 1996) has shown that the beach sediments along the west coast of India fall mostly in the range of very fine to medium class sand. Tilmathi beach sediments are an exception to this general distribution. In this paper, an attempt is made to study the textural variations of the sediments of this beach over a period of one calender year along with the study of heavy minerals.

Materials and Methods

Beach sediment samples have been collected from foreshore (high, mid, and low tide levels), by pressing a plastic core liner into the beach surface along a transect. The sample collection along with measurement of morphological changes were carried out for a period of 13 months i.e. from December 1982 to December 1983. In addition, during each survey an observation was made on environmental forcing parameters like winds, waves along this beach.

In the laboratory, the sediment samples have been subjected to mechanical analysis at the interval of 1/+ ϕ after pretreatment (Ingram, 1970). Grain size parameters were computed following Folk and Ward (1957). Selected samples were powdered and processed for heavy mineral separation using the method described by Muller (1967). The heavy minerals were identified under a microscope and

LOCATION MAP

Fig.1

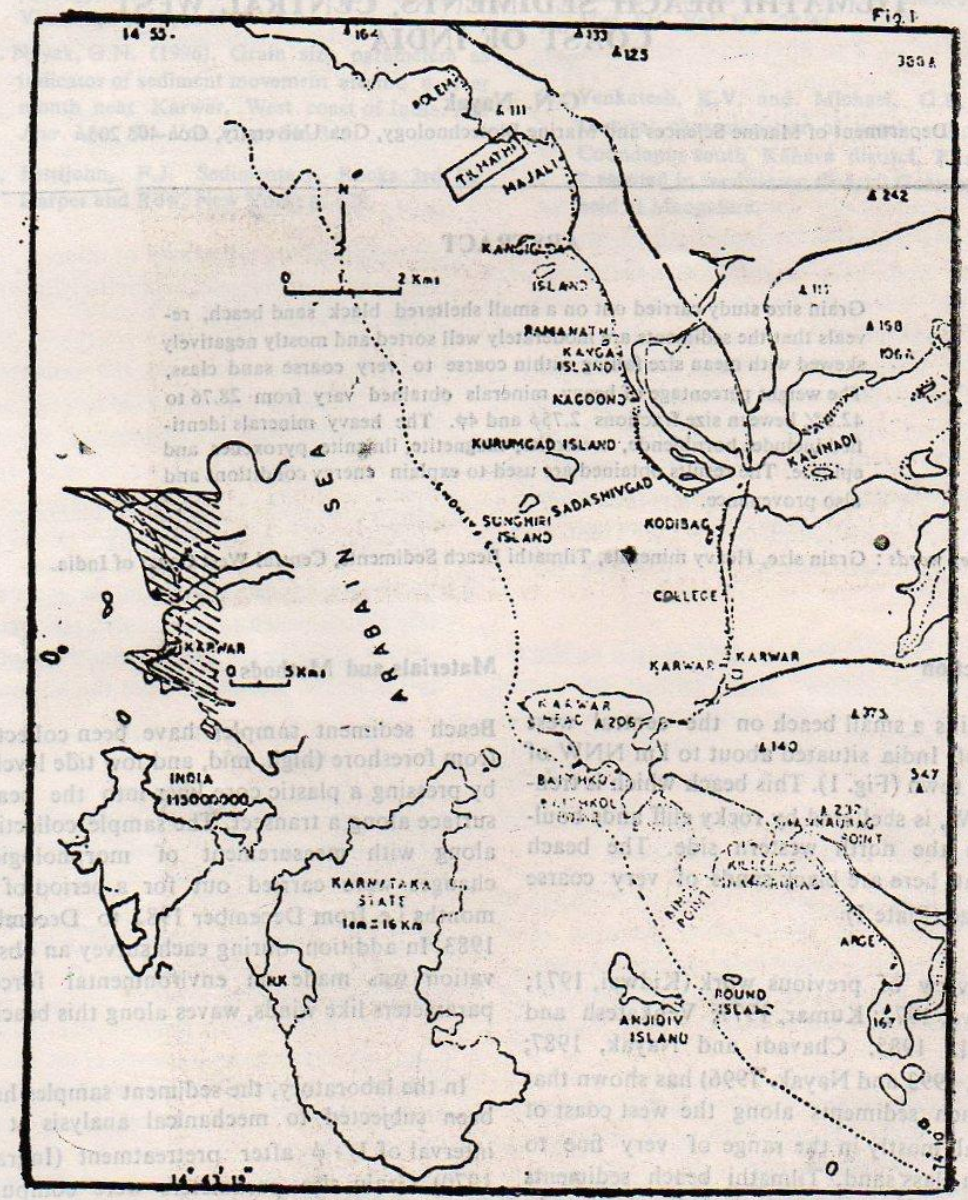
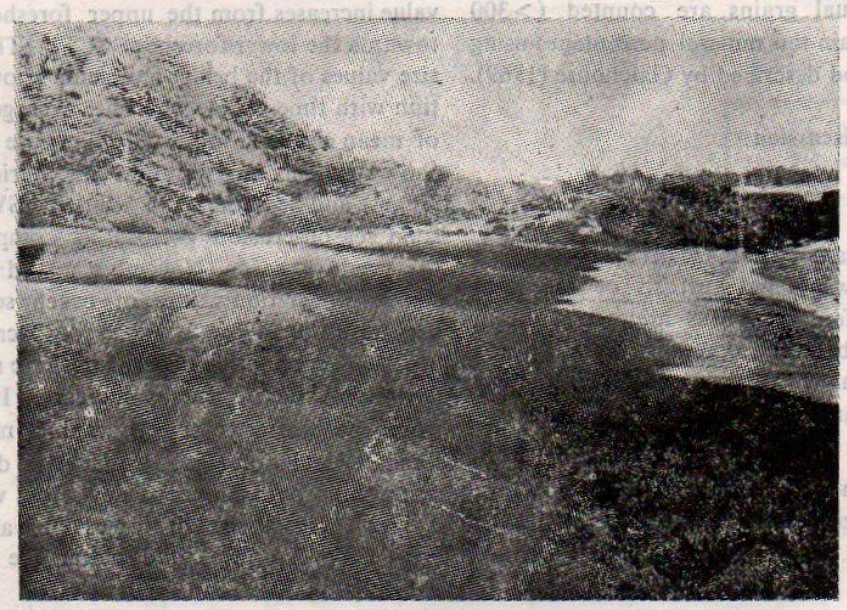
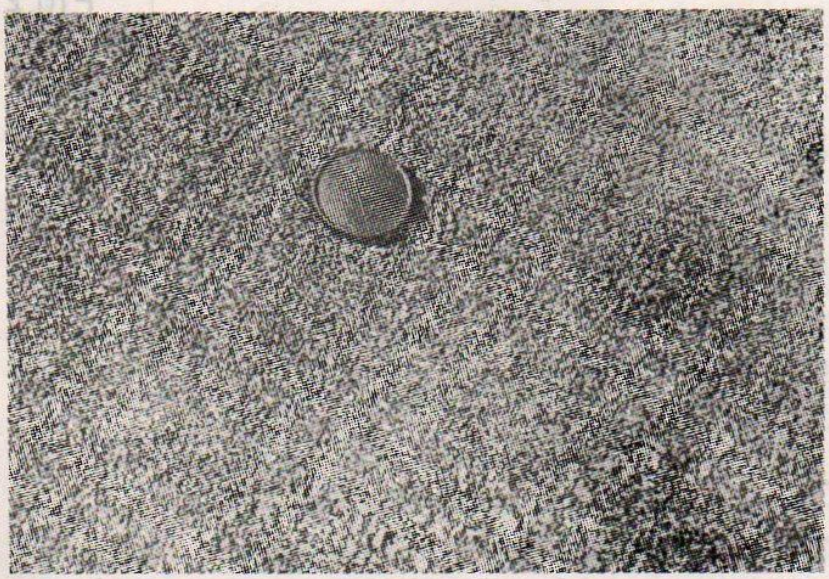


PLATE I



A



B

confirmed with the help of x-ray characteristics. Individual grains are counted (>300 grains) to obtain the mineral percentages using the line method described by Galehouse (1969).

Results and Discussion

(a) **Grain size characteristics :**

Grain size parameters viz mean size, standard deviation, skewness and kurtosis of the sediments for different months are presented in Table 1. The bivariant diagrams were plotted to know the interrelationship between different grain size parameters, (Fig. 3 and 4).

The sediments of the Tilmathi beach have their mean size in the range of $-0.66\,\phi$ to $0.84\,\phi$ (very coarse to coarse sand grade). Across the beach the mean grain size (mm) value increases from the upper foreshore (HT) towards the lower foreshore (LT). The grain size values of the beach sediments show variation with time (Table 1). The average values of mean size as indicated in figure (Fig. 2) show relatively coarser grain size during July, August and September i.e. during (SW monsoon season-erosion period) as compared to fair weather season (November to May). The standard deviation values of beach sediments vary from $0.247\,\phi$ to $0.658\,\phi$. Across the beach, from upper to lower foreshore standard deviation value in general increase. It is clear from the scatter plot of graphic mean v/s standard deviation (Fig. 3) that the degree of sorting improves (standard deviation value decreases) as mean size decreases (ϕ values increases) i e. finer the sand better the sorting.

Fig. 2.

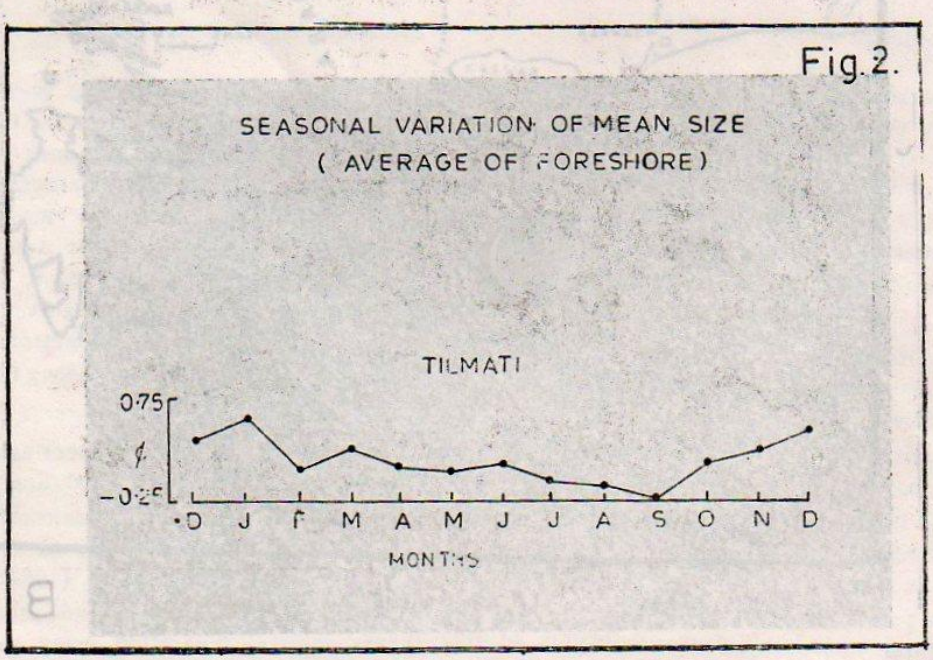
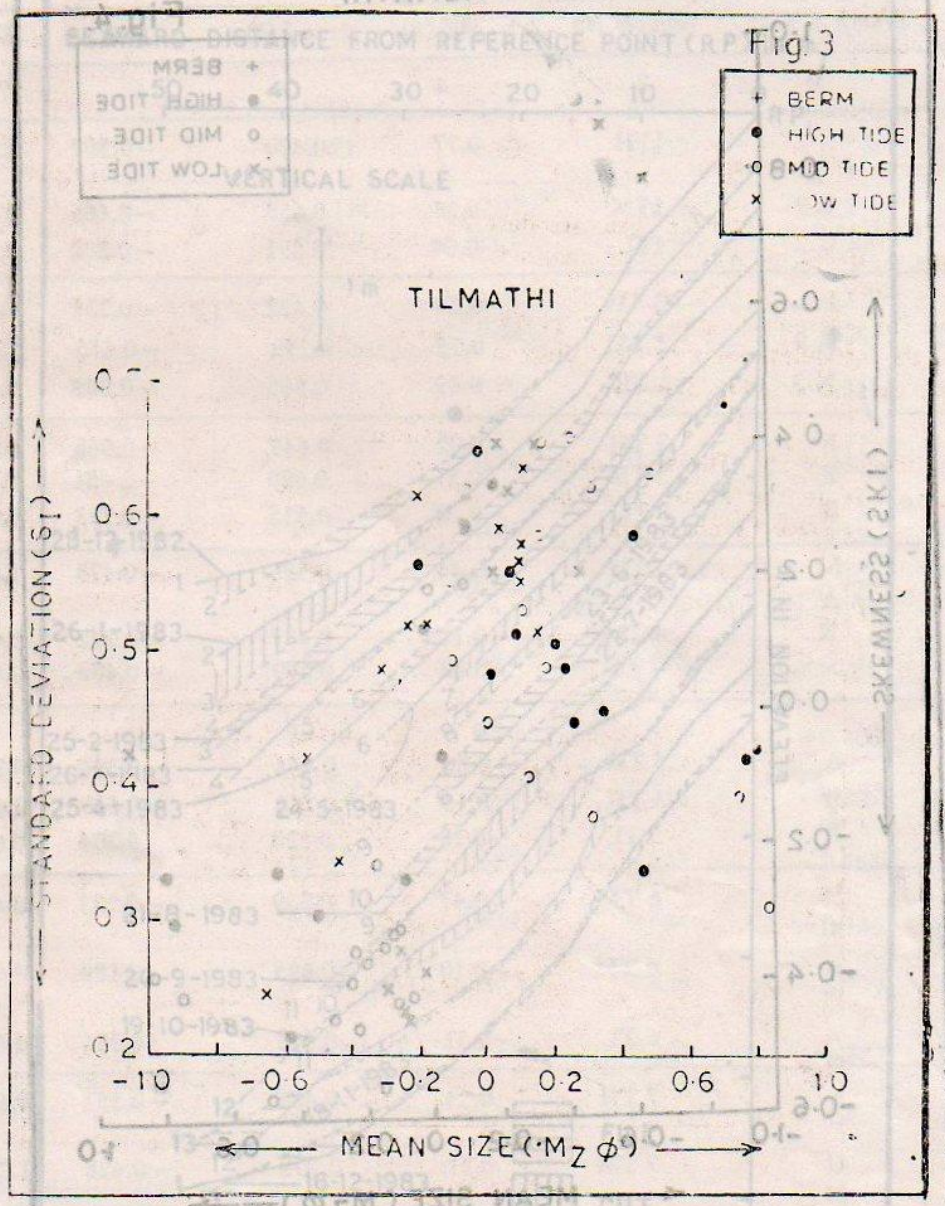
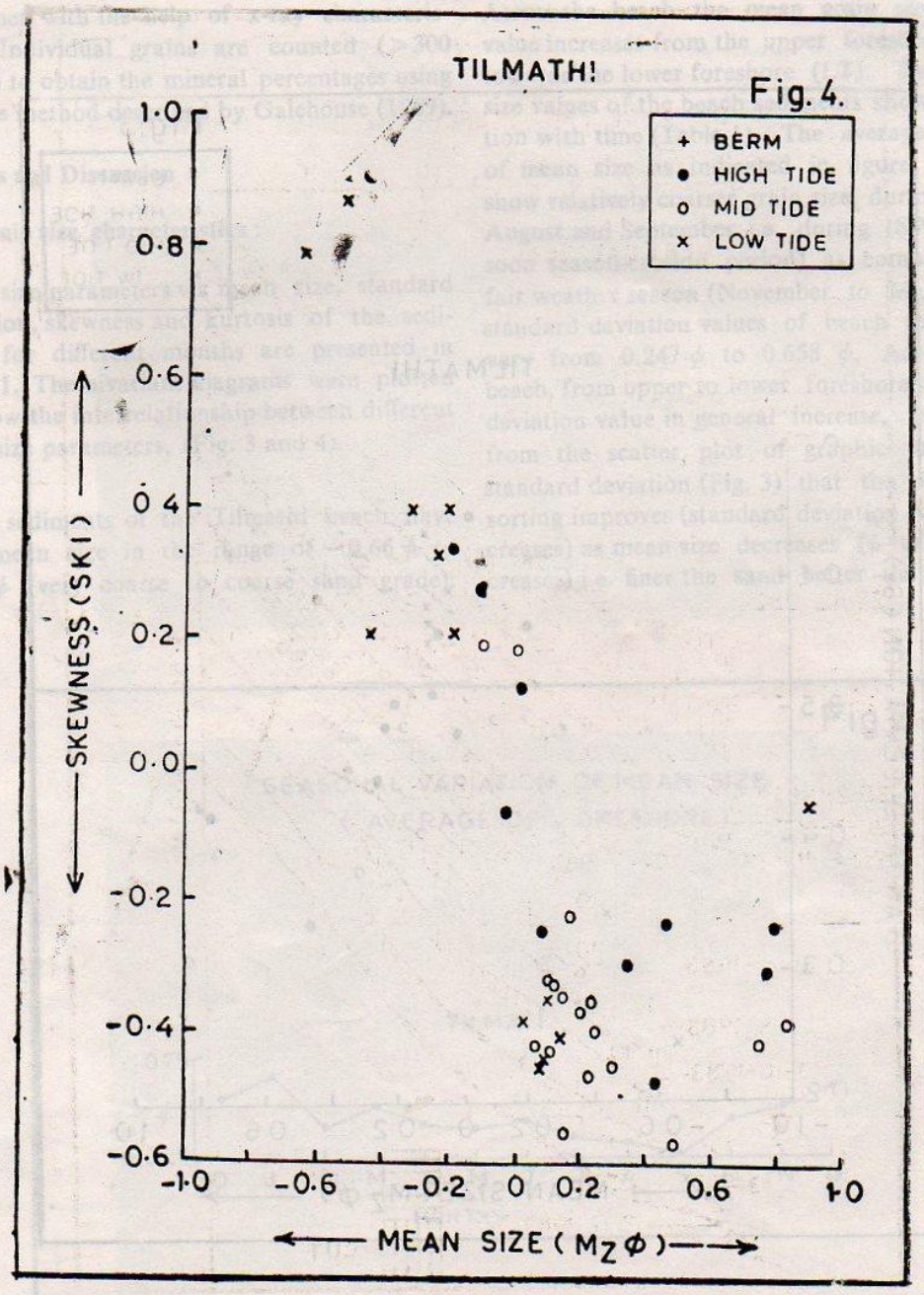


Fig. 3


+ BERM
• HIGH TIDE
o MID TIDE
× LOW TIDE
TILMATHI
STANDARD DEVIATION (σI)
0·6
0·5
0·4
0·3
0·2
-1·0
-0·6
-0·2
0
0·2
0·6
1·0
MEAN SIZE (·MZ φ)


TILMATH!
Fig. 4.
+ BERM
• HIGH TIDE
o MID TIDE
× LOW TIDE
1·0
0·8
0·6
0·4
0·2
0·0
-0·2
-0·4
-0·6
SKEWNESS (SKI)
-1·0
-0·6
-0·2
0
0·2
0·6
1·0
MEAN SIZE (MZ Φ)

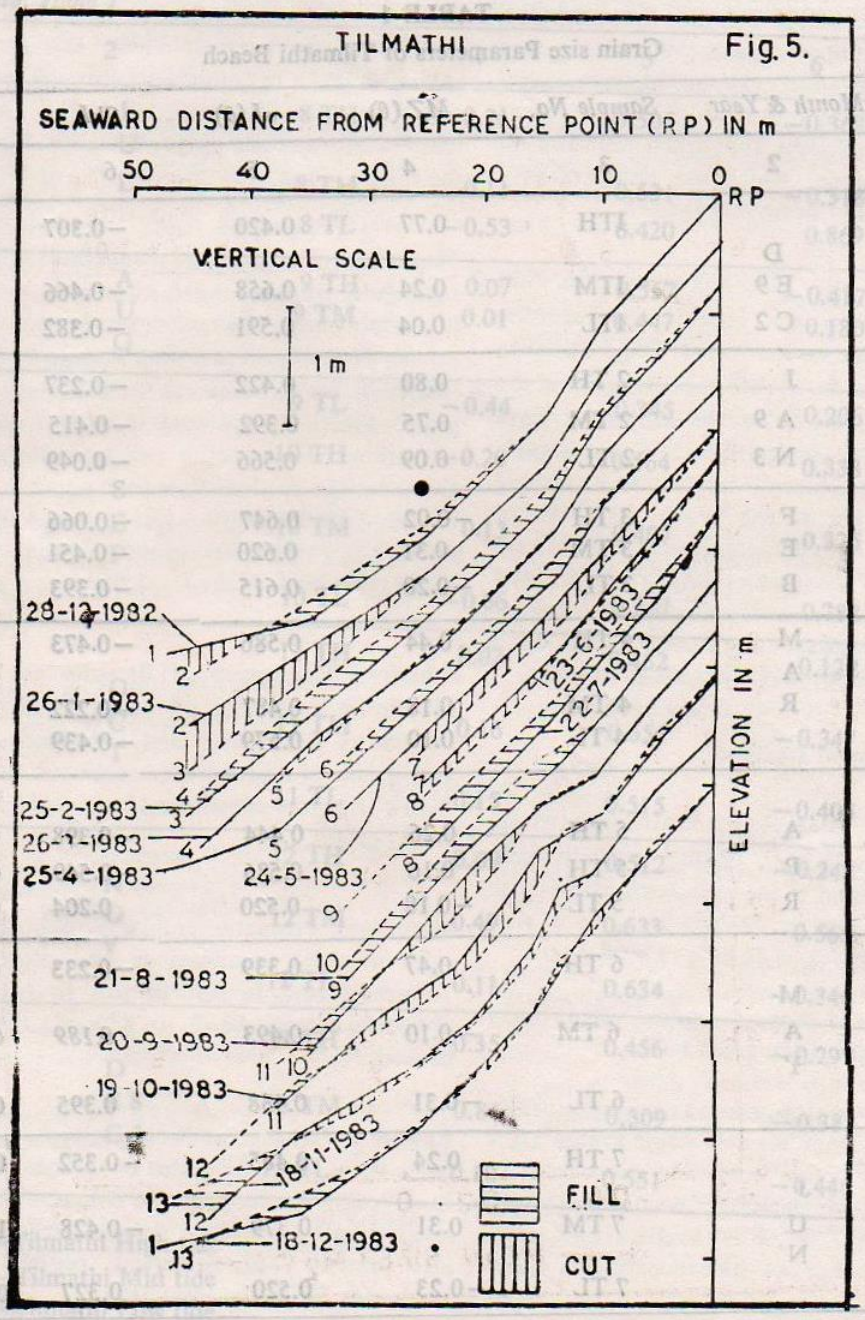

TILMATHI
Fig. 5.
SEAWARD DISTANCE FROM REFERENCE POINT (R.P) IN m
50
40
30
20
10
0
R P
VERTICAL SCALE
1 m
28-12-1982
26-1-1983
25-2-1983
26-3-1983
25-4-1983
24-5-1983
23-6-1983
22-7-1983
21-8-1983
20-9-1983
19-10-1983
18-11-1983
18-12-1983
ELEVATION IN m
FILL
CUT

TABLE 1

Grain size Parameters of Tilmathi Beach

S. No.	Month & Year	Sample No.	MZ (θ)	σI (θ)	SkI	KG
1	2	3	4	5	6	7
1		ITH	0.77	0.420	−0.307	1.938
2	D					
3	E 9	ITM	0.24	0.658	−0.466	0.638
	C 2	ITL	0.04	0.591	−0.382	0.653
4	J	2 TH	0.80	0.422	−0.237	1.222
5	A 9	2 TM	0.75	0.392	−0.415	1.772
6	N 3	2 TL	0.09	0.566	−0.049	0.579
7	F	3 TH	−0.02	0.647	−0.066	0.556
8	E	3 TM	0.31	0.620	−0.451	0.553
9	B	3 TL	−0.20	0.615	−0.393	0.652
10	M	4 TH	0.44	0.586	−0.473	1.237
11	A R	4 TM	0.18	0.487	−0.222	0.683
12		4 TL	0.10	0.579	−0.439	0.675
13						
14	A	5 TH	0.26	0.444	−0.398	0.779
	P	5 TH	0.16	0.586	−0.549	0.665
15	R	5 TL	−0.18	0.520	0.204	0.646
16		6 TH	0.47	0.339	−0.233	0.418
17	M A Y	6 TM	−0.10	0.493	0.189	0.648
18		6 TL	−0.31	0.488	0.395	0.645
19		7 TH	0.24	0.485	−0.352	0.683
20	J U N	7 TM	0.31	0.379	−0.428	1.273
21		7 TL	−0.23	0.520	0.327	0.621

Contd.

Conta. Table 1

1	2	3	4	5	6	7
22	JUL	8 TH	0.21	0.505	−0.368	0.669
23		8 TM	0.11	0.531	−0.318	0.717
24		8 TL	−0.53	0.420	0.869	1.386
25	AUG	9 TH	0.07	0.557	−0.417	0.647
26		9 TM	0.01	0.447	0.180	0.709
27		9 TL	−0.44	0.345	0.206	1.199
28	SEP	10 TH	−0.20	0.564	0.338	0.680
29		10 TM	0.13	0.407	−0.325	0.674
30		10 TL	−0.66	0.247	0.788	1.073
31	OCT	11 TH	0.02	0.482	0.122	0.784
32		11 TM	0.16	0.656	−0.347	0.660
33		11 TL	0.15	0.515	−0.405	0.613
34	NOV	12 TH	0.09	0.512	−0.242	0.771
35		12 TM	0.49	0.633	−0.565	1.054
36		12 TL	0.11	0.634	−0.346	0.626
37	DEC 3	13 TH	0.35	0.456	−0.297	1.575
38		13 TM	0.84	0.309	−0.385	2.131
39		13 TL	0.10	0.551	−0.446	0.686

TH—Tilmathi High tide
TM—Tilmathi Mid tide
TL —Tilmathi Low tide

The skewness values of the sediments range from −0.565 to 0.869. The plot between mean and skewness (Fig. 4) reveals that very coarse sediments are positively skewed, whereas coarse sands are negatively skewed. Thus, it is clear that during monsoon the beach consists of very coarse sands which are comparatively poorly sorted and positively skewed.

Observation on Morphology reveals that the beach is steep and insignificant variation from one month to the other (Fig. 5). Even over a period of one year, the changes in the net erosion/deposition of the sediments have been found to be insignificant. This insignificant variations in morphology can be attributed to the orientation of the beach, its sheltered nature to the wave activity. However, relatively coarse grained sands observed during monsoon season could be due to the slightly high energy waves of southwest monsoon as has been reported by Veerayya, (1972) off Goa coast.

(b) **Heavy mineral studies :**

The heavy mineral concentration (wt %) varies between 28.76 to 42.80%. The concentration was found to increase with decrease in sediment size. It is 28.76% in 2.75 ϕ size, 39.46% in 3.25 ϕ and 42.80% in 4.00 ϕ size.

The diagnostic properties of individual heavy minerals identified are given below.

Tremolite : Tremolite occurs as prismatic grains with diagonal fractures and rugged end. It is light green in colour and non pleochroic in nature. The characteristic 'd' values have been noted at 8.305, 3.155, 3.099 and 2.072 A° along with many other peaks. Its concentration varies from 23 to 29%.

Hornblende : Prismatic grains of hornblende have more or less rounded ends, elongated outlines are also present. These are green to yellowish green in colour and strongly pleochroic. Few grains have been altered to chloritic matter. Hornblende ranges from 19 to 20% of the total heavies.

Magnetite : The grains of magnetite are mostly subangular to subrounded, silver grey to black in colour with triangular pits in some of the grains. Few magnetite grains contain haematite (martite), which occur in the periphery of the grain. Martite is formed due to secondary alteration of magnetite (martitisation). The characteristic *d* values have been noted at 4.835, 2.9591, 2.5219, 1.6104, 1.4806 and 1.0930 A° along with many other peaks. Magnetite constitute 19 to 20% of the total heavies.

Ilmenite : The grains of ilmenite are weakly pleochroic in shades of brown. This occurs mostly as subangular and subrounded grain. Few grains of ilmenite are associated with haematite. Ilmenite constitute 19 to 21% of the total heavies.

Pyroxene : Prismatic grains of clinopyroxene with irregular terminations give more or less rounded forms. It is brownish to colourless. Pyroxene constitute 7 to 8% of the total heavies.

Epidote : Subangular to slightly rounded and some times irregular grains of epidote are commonly seen. Epidote is more commonly colourless but pale greenish to pale yellow grains are also present. The numerical proportion of epidote is 5% of the total heavies.

The heavy minerals are used to specify the type of source from which they have been derived (Krumbein and Pettijohn, (1938); and Pettijohn (1984). The Tilmathi beach is sheltered by rock cliffs of amphibolites (Nayak, 1993). Therefore, for discussing the provenance of this beach sediments, the mineralogy of the rock types exposed on sea cliffs are important, as they are continuously acted upon by waves. Amphibolite varies in structure from schistose to massive type. This consists of hornblende, plagioclase, quartz, clinopyroxene, epidote, magnetite, ilmenite and chlorite. Bands of ultramafic units occur within amphibolite bodies which consists of tremolite, talc, chlorite, magnetite and ilmenite.

It is thus clear that practically all the minerals identified in the sediments of the Tilmathi beach can be traced bock to the rocks of the coastal cliffs.

From the present study which is based on the field and laboratory investigations of the sediments of Tilmathi beach, the following conclusions are drawn.

1. Tilmathi beach consists of coarse grained black sand.
2. Sediments of the Tilmathi beach are coarse grained but more coarser sediments occur during monsoon season as compared to fairweather season.
3. These sands are composed of mineral like tremolite, hornblende, magnetite, ilmenite, pyroxene and epidote.
4. The minerals identified in the sediments of the Tilmathi beach can be traced back to the rocks of the surrounding coastal cliffs.
5. Heavy mineral concentration increases as the grain size decreases (mm).
6. The beach sands of Tilmathi are moderately sorted which is due to the sheltering nature of the beach and shorter transportation of the sediments from the source.

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