

14621
TEXTURAL STUDIES OF BEACH SEDIMENTS FROM SADASHIVAGAD AND KARWAR,
CENTRAL WEST COAST OF INDIA

P.G. MISLANKAR

National Institute of Oceanography, Dona Paula, Goa 403004

and

F.B. ANTAO

Dempe College of Arts & Science, Miramar, Goa

ABSTRACT

Analysis of textural parameters such as mean grain size, standard deviation, skewness and kurtosis was done for 48 surface sediment samples of two close but separate beaches, namely Sadashivagad and Karwar, in the Central West Coast of India. Frequency distribution curves for both the beach sediments differ in their modal class showing unimodal to weakly bimodal trend for the Sadashivagad and strongly bimodal to unimodal trend for the Karwar beach sediments. The plots of mean grain size vs skewness seems to be most effective in differentiating the environment of deposition. The plots of mean size vs. standard deviation show a progressive increase in sorting with decrease in mean grain-size for both the beach sediments of the Sadashivagad and the Karwar. Symmetrical skewed sediment distribution on the Sadashivagad beach indicate slow rate of deposition whereas negatively to positively skewed sediment distribution on the Karwar beach indicate strong winnowing and deposition. Gradual decrease in mean grain size from north to south in the Karwar beach indicates the direction of movement of sediments towards south and southwest of the Kali river, compared with the sediments of the Sadashivagad beach which is composed of medium to fine sand with 80% samples having symmetrical skewness, though both the beaches are adjacent and exposed to identical oceanographic conditions.

INTRODUCTION

Variability of the textural parameters in sediment of different beaches is a result of a somewhat complex response to several factors like sediment movement, wind direction, wave refraction, physiography of the area and sediment supply.

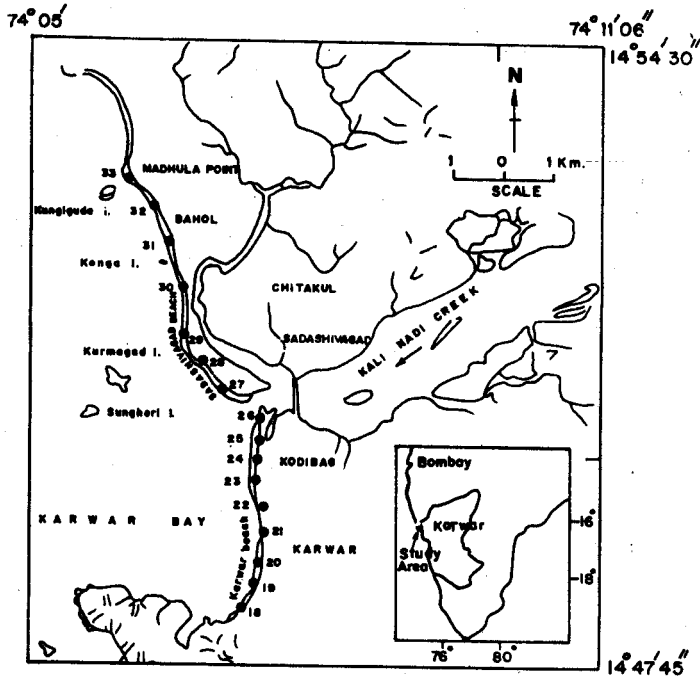
This paper presents the variability of the textural parameters and the sediment transport on two beaches, viz. Sadashivagad and Karwar which are on either side of Kali river at a distance of 0.4 km. The change in textural parameters, like mean grain size, sorting, skewness, kurtosis, frequency distribution curves and bivariate plots have been utilised to infer the

depositional environment and the sediment transport direction.

PREVIOUS WORK

In the area of present study the investigations are mainly carried out particularly on wave refraction and sediment transport on the basis of tracers. Venkatesh and Ray (1976) studied sediment transport on the Karwar beach using tracer and stated that the wind induced current from north west, when they strike the beach get refracted towards the offshore in a west and south-west direction. The wave refraction and littoral transport along the shoreline from Cape Ramas to Karwar was carried out by Gouveia *et al.* (1976) and observed that the deep water

SAMPLE LOCATION MAP OF STUDY AREA



Solid dots represents sampling stations

Fig. 1 : Sample Location Map. The numbered solid dots represent sampling stations

GEOLOGY OF THE AREA

The coastal belt comprising the study area exposes granites, granodiorite, metabasalt, Precambrian metamorphics and dolerite dykes which are then overlain by laterite and alluvium (Mislankar *ibid*). The Kali a major river in the north Karnataka, drains through a metamorphic terrain consisting of the Precambrian gneisses and granites, granitic gneisses, schists and charnockite, which are traversed by a number of basic dykes (Kidwai *et al* 1981), and debouches in the Arabian Sea between Kodibag and Sadashivgad developing prominent shoals in southern side of its mouth.

waves approaching from north west (330°) and that the littoral currents are directed towards south all along the coast under study. Veerayya and Pankajakshan (1988) stated that the open beach at Sadashivgad-Ramnath are characterised by either converging/or on-offshore flows. The wave induced currents at the Kali river entrance are found to be directed towards its mouth because of the fanning away of refracted wave rays leading to sediment deposition at the entrance. Detailed study of the heavy minerals and the textural parameters were carried out by Mislankar (Unpubl. M.Sc. thesis Bombay Univ., 1988) to evaluate the mineralogical provenance and the depositional environment in this area.

METHODS

48 samples of sediments were collected along 16 sampling stations (Fig. 1) using acrylic tube (20cm long with 45 mm diameter). At each transect three samples were collected during low tide, one at high and one at intermediate tide level. The samples were then coned and quartered. The sediments which are devoid of clay and silt were washed to remove salt and about 50 gm of each sample was analysed using standard sieves at half phi interval. Weight percentage, cumulative weight percentage, frequency distribution and textural parameters such as mean, standard deviation, skewness and kurtosis were computed for each sample following the method of Folk and Ward (1957), using a

ND-520 computer. Frequency curves and scatter plots were made to determine the interrelationship between the parameters.

TEXTURAL PARAMETERS

The grain size data reveal that the Sadashivagad beach, located north of the Kali river mouth, is composed of medium to fine sand ($Mz 1.82 \phi - 2.6 \phi$) and the Karwar beach, located south of the Kali river mouth, is composed of coarse to fine sand ($Mz 0.45 \phi - 2.80 \phi$). The Sadashivagad beach sediments are well to moderately well-sorted ($0.43 \phi - 0.86 \phi$) with a near symmetrical to negative skewness (+0.09 to -0.25) and their kurtosis values range from platykurtic to very leptokurtic

TABLE 1 : TEXTURAL PARAMETERS OF THE SADASHIVAGAD AND THE KARWAR BEACH SEDIMENTS : (A) HIGH, (B) MID AND (C) LOW TIDE LEVELS

SAMPLE NO	MEAN SIZE ($Mz\phi$)	STD DEVIATION (σ_1)	SKEWNESS (S_{ki})	KURTOSIS (k_G)	
33 A	2.24	0.43	+0.02	1.03	
B	2.22	0.46	+0.07	0.89	
C	2.47	0.44	+0.07	0.89	
32 A	2.30	0.54	-0.17	0.99	
B	2.48	0.57	-0.19	0.93	
C	2.44	0.54	-0.14	0.98	
31 A	2.13	0.17	+0.09	1.20	
B	1.98	0.51	+0.08	1.26	
C	2.00	0.69	-0.04	1.31	
30 A	2.25	0.49	+0.00	0.81	SADASHIVAGAD
B	1.82	0.86	-0.01	1.28	
C	2.19	0.78	+0.06	1.08	BEACH
29 A	2.20	0.45	+0.03	0.92	
B	2.48	0.48	-0.08	1.82	
C	2.60	0.52	+0.19	1.17	
28 A	2.04	0.45	+0.03	1.30	
B	2.18	0.46	+0.01	0.91	
C	2.20	0.73	-0.06	1.07	
27 A	1.85	0.46	+0.01	1.57	
B	2.22	0.57	-0.11	1.10	
C	2.35	0.64	-0.25	1.28	

TABLE 1 (Contd.) :

SAMPLE NO	MEAN SIZE	STD DEVIATION	SKEWNESS	KURTOSIS
26A	1.23	0.56	+0.27	0.69
B	0.82	0.62	+0.32	1.77
C	0.45	0.50	+0.20	1.44
25 A	1.65	0.67	-0.19	0.64
B	1.46	0.70	-0.17	0.76
C	0.72	0.90	+0.20	0.78
24 A	2.03	0.39	+0.18	0.88
B	1.61	0.65	-0.24	1.10
C	1.00	0.77	+0.35	0.84
23 A	1.47	0.55	-0.34	0.80
B	1.42	0.58	-0.29	0.73
C	0.96	0.59	+0.36	0.81
22 A	2.63	0.41	-0.16	0.94 KARWAR BEACH
B	2.36	0.54	0.00	0.81
C	2.31	0.50	+0.02	0.88
31 A	2.80	0.35	-0.67	1.81
B	2.19	0.57	+0.17	1.29
C	2.31	0.64	-0.08	0.81
20 A	2.46	0.42	-0.02	1.18
B	2.42	0.50	-0.04	0.96
C	1.94	0.56	+0.18	1.51
19 A	2.42	0.57	-0.13	0.96
B	2.24	0.70	-0.08	0.96
C	2.08	0.92	-0.30	0.87
18 A	2.28	0.35	-0.09	2.32
B	2.70	0.43	-0.17	1.37
C	2.54	0.57	-0.30	1.01

(0.81 to 1.82, Table 1). The Karwar beach sediments on the other hand are very well to moderately well-sorted (0.35ϕ to 0.92ϕ) and positively to negatively skewed (+0.36 to -0.67) with their kurtosis values range from very platykurtic to very leptokurtic (0.64 to 2.32, Table 1).

INTERPRETATION OF FREQUENCY CURVES AND SCATTER PLOTS

The frequency distribution curves for the Sadashivagad and the Karwar beach sediments differ in their modal class. The Sadashivagad beach sediments are weakly bimodal to

unimodal (Fig. 2) from the river mouth to north (Stn. No. 27 to 33) with the primary mode between 2 to 3 ϕ size class and show a weak secondary mode in 1 ϕ size class, whereas the Karwar beach sediments are strongly bimodal (Stn. No. 26 to 23) with primary mode in 1 ϕ size class (coarse mode) and the sediment distribution becomes weakly bimodal to unimodal from river mouth to south of this beach (Stn. No. 22 to 18, Fig. 3).

The bivariate scatter plots employing different size parameters, indicate the difference in the depositional environments for the Sadashivagad and Karwar beach sediments. The

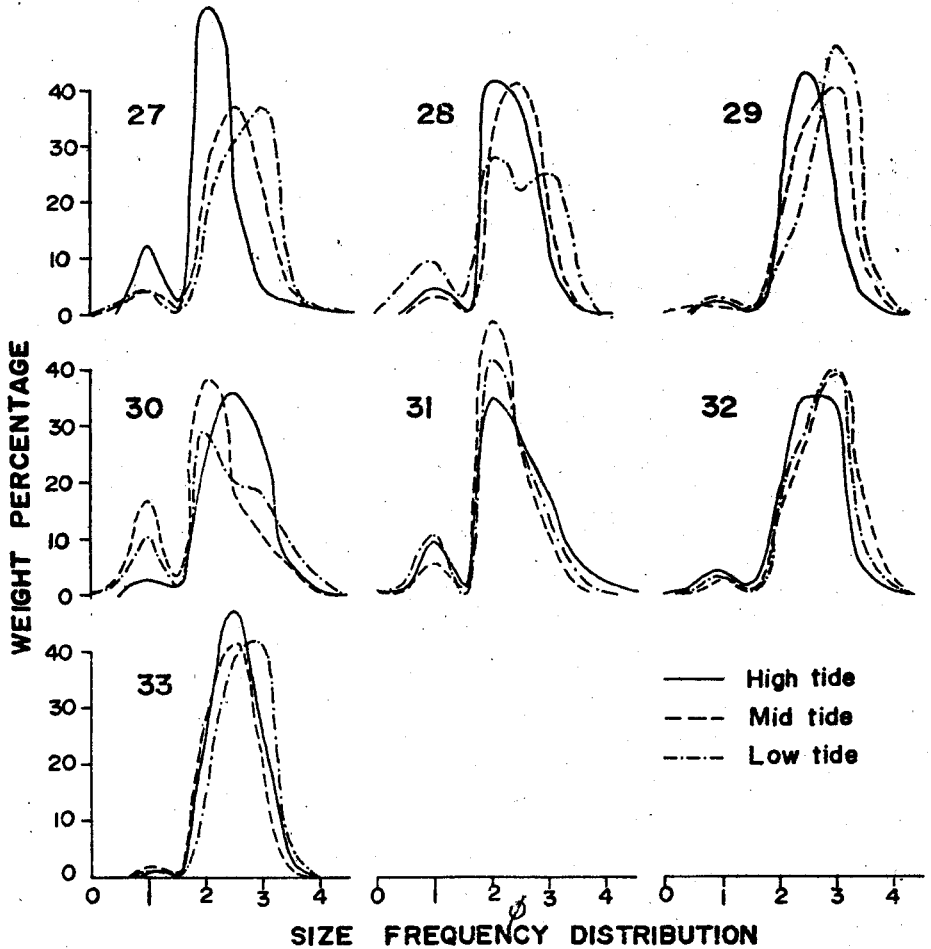


Fig. 2 : Frequency grain-size distribution curves for beach sands of the Sadashivagad ; number represents sampling station.

beach sediments of the Sadashivagad and the Karwar shows the overall dominance of mixed environment (river and dune) (Friedman 1961). However the dune environment shows some prominence in Karwar beach sediments to that of Sadashivagad (Fig. 4). Among the scatter plots, the mean diameter vs skewness is more effective in differentiating the depositions of environment (Friedman 1961 ; Moila and Weiser 1968 ; Fig. 4). The plots of mean grain size vs

standard deviation show a progressive increase in sorting with decrease in mean grain size for both the beach sediments (Fig. 4).

COMPARATIVE RESULT

The mean size for Sadashivagad beach sands clusters between 2 to 2.5 ϕ with the mean size of 80% of the samples being in 2.25 ϕ with a standard deviation of 0.1 ϕ (Fig. 5) ; on the other hand the Karwar beach sediments show

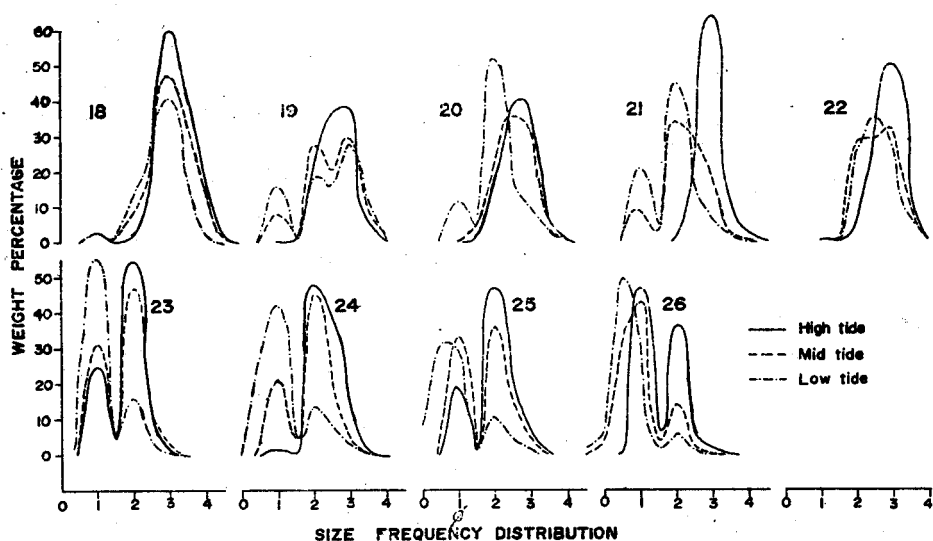


Fig. 3

Fig. 3 : Frequency grain-size distribution curves for beach sands of the Karwar ; number represents sampling station.

wide variation in mean grain size range (0.60 to 3.0 ϕ) with a standard deviation 1.3 ϕ (Fig. 5). The sorting values of both the beaches do not show much variation compared with other textural parameters (Fig. 5). Skewness however indicates some difference between the two beach sediments. The Sadashivagad beach sediments show a nearly normal distribution of skewness grouped about a mean skewness of +0.05 (Fig. 5), whereas the Karwar beach sediments has a distinctly polymodal distribution of skewness values (Fig. 5) with a very positively to very negatively skewed sediment distribution.

DISCUSSION

Though both these beaches are adjacent and acted by similar oceanographic condition, the difference in their textural parameters is

probably due to the difference in the sediment dispersion brought by Kali river. Medium to fine sand with weakly bimodal to unimodal frequency distribution with symmetrical skewed sediment distribution probably indicate the slow rate of deposition and erosion (Daune 1964), and coarse to fine sand with strongly bimodal to unimodal frequency distribution for the Karwar beach with negatively to positively skewed sediment distribution probably indicate strong winnowing and deposition (Daune 1964). The bivariate plots of these two beach sediments also suggest difference in their depositional environment. Among the scatter plots the mean grain-size vs skewness is more effective in differentiating the depositional environment among these two beaches. The gradual decrease in mean grain size with strongly bimodal to

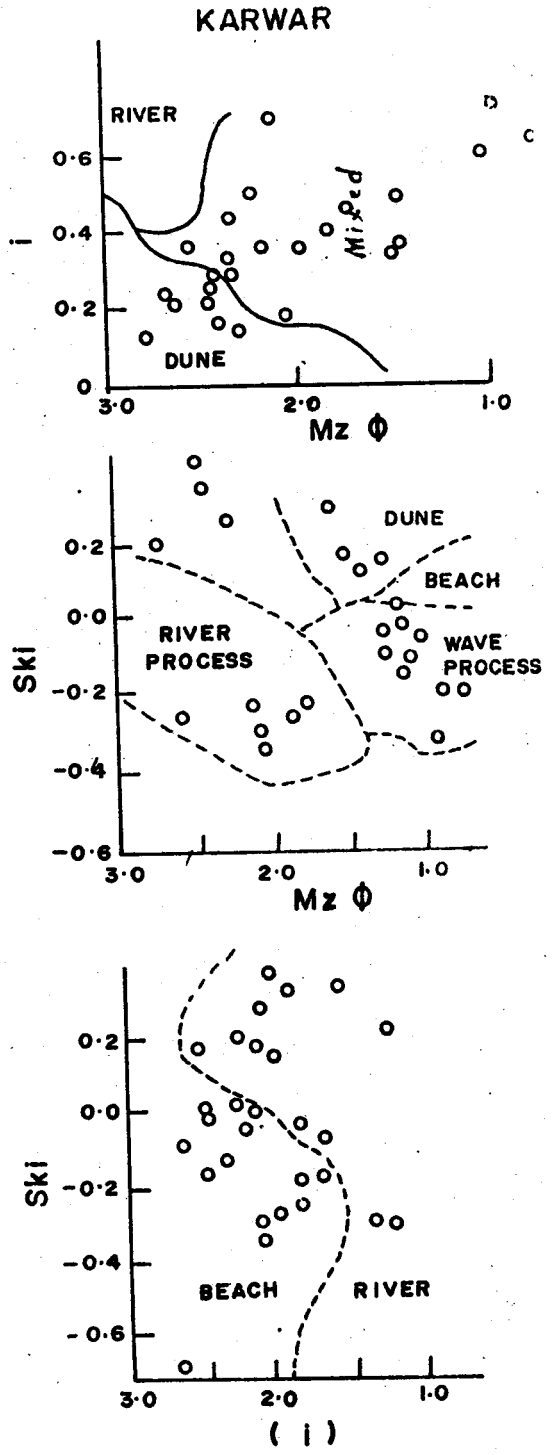
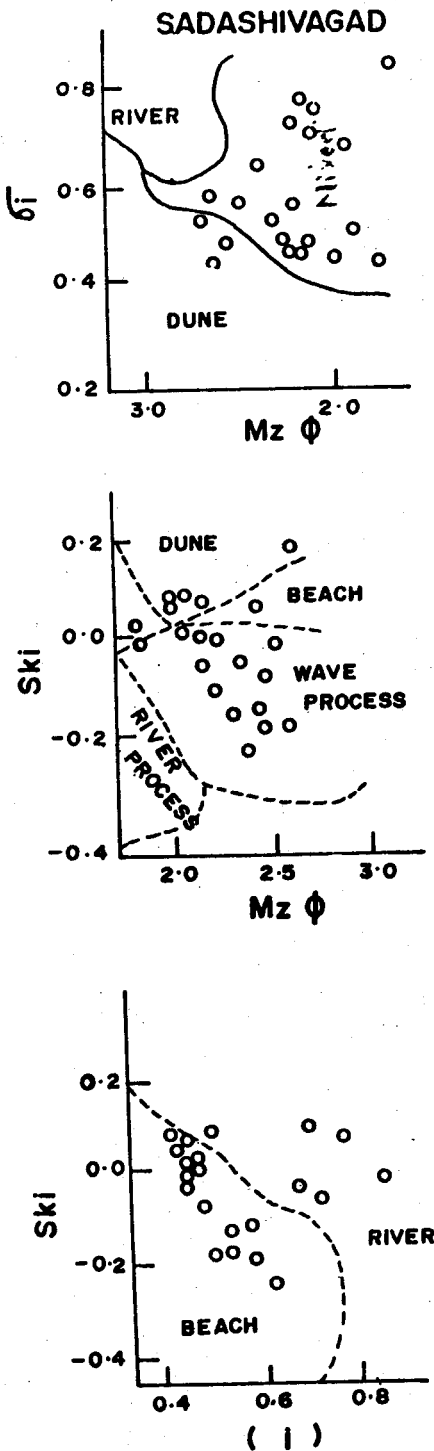


Fig. 4 : Bivariate scatter plots from different parameters for the Sadashivagad and the Karwar beach sediments. Field of demarcation after Moila and Weiser (1968) and Friedman (1961).

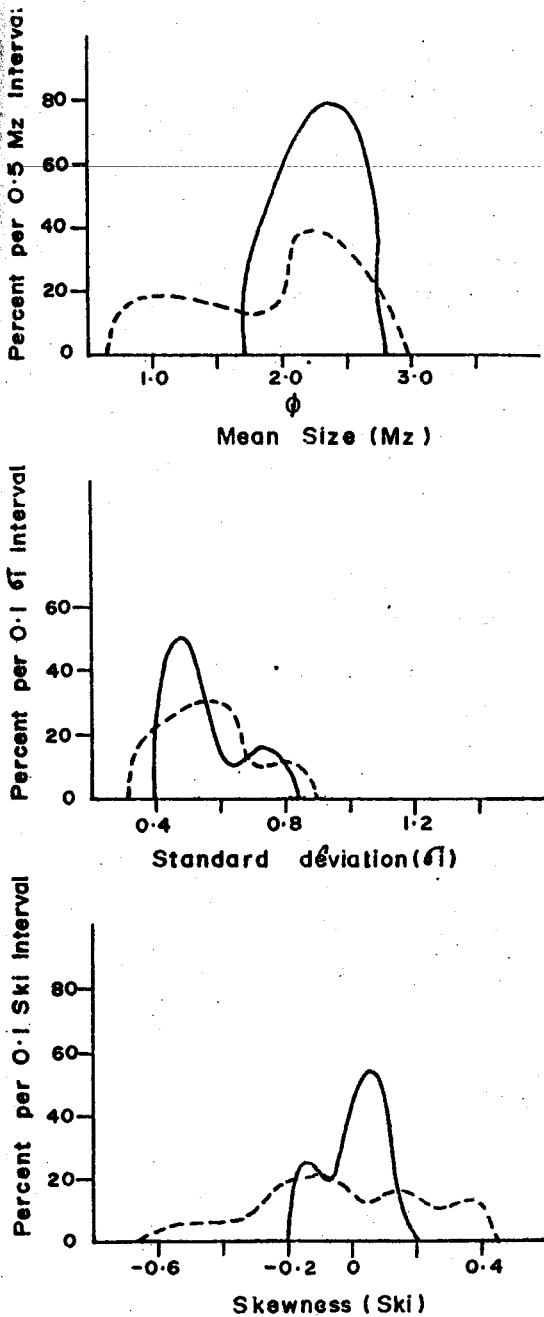


Fig. 5 : Frequency distribution of Mz ϕ , σ_1 and Ski for the Sadashivagad (dark line) and the Karwar (dash line) beach sediments

unimodal frequency distribution on the Karwar beach from river mouth to south probably indicate the sediment transport towards the south and south-west, which may be due to fanning away of the refracted wave rays leading to the sediment deposition at the entrance of the river mouth (Veerayya and Pankajakshan 1988) which are transported further south due to prevailing southerly littoral current (Gouveia *et al.* 1976). Moreover the Kali river runs south westerly near the confluence point (Fig. 1), which may be the reason for the finer material being deposited towards the north of the river leaving coarser material for the south (Awasthi 1970). Tracer study near the confluence point of the Kali river (Venkatesh and Ray 1976) revealed the sediment movement towards south and south-west. The Karwar beach sediments show mixed environment of deposition while the Sadashivagad beach sediments show beach environment of deposition (Fig. 4).

Though there is a variation in mean grain size in the two beach sediments, their sorting values do not differ much. This may be due to the riverborne sediments which are directly deposited on north of the Karwar beach which may not have mixed with the beach environments leading to less effective in sorting so that the two distributions retain their individual characteristics with respect of the sorting values (Folk and Ward 1957). From the results it is concluded that of all the grain size parameters the sign of skewness is most sensitive parameters in differentiating the environment of deposition and it is also observed that the modality and the mean grain size can suggest the sediment transport direction.

ACKNOWLEDGEMENT

We thank Dr B.N. Desai, Director, National Institute of Oceanography Goa and Mr R.R. Nair, Head, Geology Division, for their permission to publish this work. We also thank Dr. N.H. Hashimi, Shri A.R. Gujar and Shri Iyer Sridhar for their valuable suggestions.

REFERENCES

- Awasthi, A.K. 1970 : Skewness as an environmental indicator in the Solani river system, Roorkee, India. *Sediment. Geol.*, 4, 177-183.
- Daune, D.B. 1964 : Significance of skewness in recent sediments, Western Pamlico south, north Carolina. *Jour. Sed. Petrol.*, 34, 864-874.
- Folk, R.L. and Ward, W.C. 1957 : Brazos river bar—a study in significance of grain size parameters. *Jour. Sed. Petrol.*, 27, 3-26.
- Friedman, G.M. 1961 : Distinction between dune, beach and river sands from their textural characteristics. *Jour. Sed. Petrol.* 31, 514-529.
- Gouveia, A.D., Joseph, P.S. and Kurup, P.G. 1976 : Wave refraction in relation to beach stability along west coast, from Cape Ramas to Karwar Mahasagar. *Bull. Natl. Inst. Oceanogr.*, 9, 11-18.
- Kidwai, R.M., Nair, R.R. and Hashimi, N.H. 1981 : Heavy minerals in the sediments on the outer continental shelf between Vengurla and Mangalore on the west coast of India. *Indian. Jour. Mar. Sci.*, 22, 32-38.
- Moila, R.J. and Weiser, D. 1968 : Textural Parameters : An evaluation. *Jour. Sed. Petrol.*, 38, 45-53.
- Veerayya, M. and Pankajakshan, T. 1988 : Variability in wave refraction and resultant nearshore current pattern : exposed versus sheltered beaches along north Karnataka, west coast of India. *Indian. Jour. Mar. Sci.*, 17, 102-107.
- Venkatesh, K.V. and Ray, I. 1976 : A note on the study of sediment movement at Karwar. *Jour. Geol. Soc. India.*, 17, 399-400.

Manuscript Received January 11, 1992

Revised Manuscript Received July 12, 1992