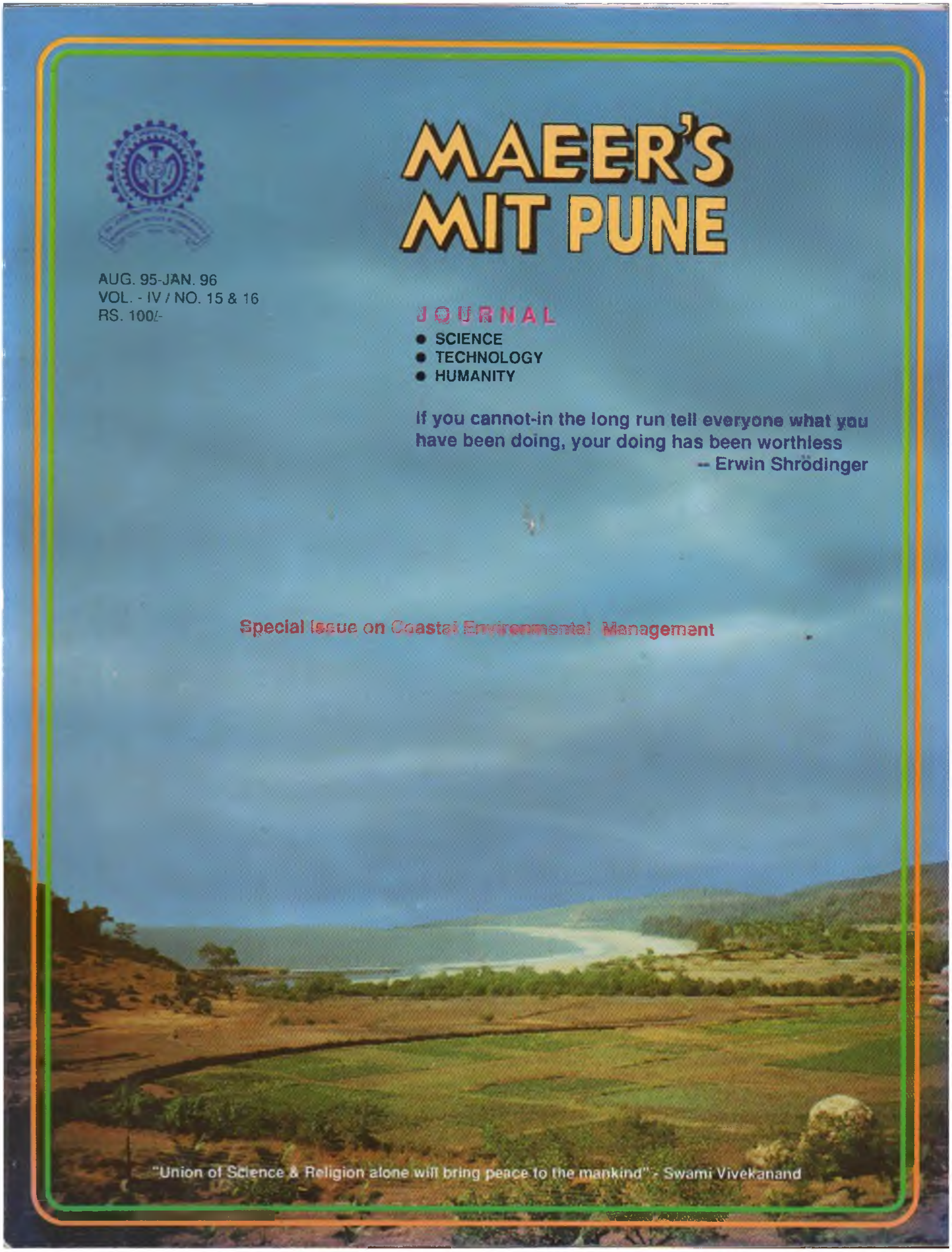

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If you cannot-in the long run tell everyone what you have been doing, your doing has been worthless
-- Erwin Shrödinger

Special Issue on Coastal Environmental Management

"Union of Science & Religion alone will bring peace to the mankind" - Swami Vivekanand

BEACH DYNAMISM VS CLIMATIC CHANGES

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ABSTRACT

Beach studies over the globe, have gained importance either due to the dynamic changes within this environment and their effects, or due to their economic viability with respect to placer mineral deposits. In India due to its long coast line the subject has attracted many research workers. Studies carried out along a stretch of coastline on the central west coast of India showed that the different types of beaches show a remarkable significance in changes in response to wave climate affecting the coast. Since West Coast of India has a tropical maritime and monsoonal type of climate, seasonal changes are distinct. The wave climate associated with monsoon season, brings about dramatic changes in beach configuration, with extensive erosion of backshore which many a time reaches alarming limits. The fairweather season (Pre and post monsoon) show a constructive activity with intermittent minor erosion periods resulting in most of the beaches. cyclic behaviour.

INTRODUCTION

If you visit the coast frequently, you will almost certainly have noticed that beaches of coarse sand, shingle are steeper than these made of fine sand. You may also be aware that in the summer when fair weather conditions normally prevail, the beach may be steeper than in monsoon or winter when the sea is often stormy. Clearly both sediment grainsize and wave type affect the beach profile.

In this article a year long study carried out on coastal stretch of Northern part of Karnataka (Karwar) and small part of Goa (South) is presented. Trending NNW - SSE, the coast in this stretch is nearly a straight line except for two shallow bays in the north viz the Karwar bay and the Belekeri bay (Fig. 1). The coast comprises of rocky offshore islands, small beaches between promontories, cliffs and river mouths. The promontories cliffs and islands are composed of granitic geneiss, amphibolite schists, basic dykes and laterite cover.

Earlier studies on this part of coast were pertaining to the longshore currents (Reddy and Varadachari , 1972 and Goureia et al. 1976) and some aspects of Anjidi islands off Karwar by Kumar (1977 and 1980). In addition, Veerayya and Pankajakshan (1988) worked on longshore currents using wave refraction along a part of this coast. Detailed studies were undertaken from 1982 along segments of this coast for Ph.D and M. Phil programmes by the team of workers from Department of Geology of Karnatak University Dharwad. The author of this article started this programme in 1982 under the guidance of Prof. V.C. Chavadi.

Summerizing various works, the morphological characterstics of beaches between polem and Honnavar are as follows

a) The beach morphological changes are cyclic over a period of one year.

b) Erosion commences in late April and attains significant mangnitude by June.

c) Even though erosion continues upto July/August, the rate of erosion decreases considerably after the initial rapid rate.

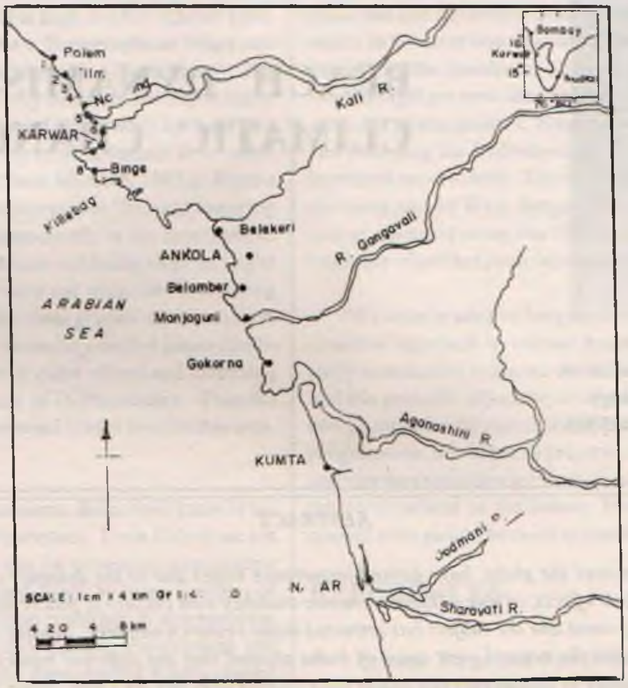

Fig. 1 location map of study area

d) During the above period (c) recession of the shoreline takes place considerably.

e) After the beaches show minimum storage of sediments (lowest elevation in the morphology of the beach) during July/August, the beaches tend to grow upto March/April.

f) During this accretionary period, a secondary phase of erosion occurs during Novermber/December at few locations and in February/March at the other locations.

The beaches along the study area can be grouped as pocket, sheltered and linear type of beaches and all the three types undergo the above mentioned stages of erosion/accretion. Though all the three types namely pocket, sheltered and linear beaches undergo above mentioned stage of erosion/accretion, they vary from each other in their magnitude of variation. In the pocket type of beach, development of broad berm during April/May (Fig. 2) and erosion of higher magnitude during early monsoon is prominent. On the other hand in the sheltered type, berm is almost absent (Fig. 3) and erosion during early monsoon is less prominent (Nayak, 1988). In the case of linear beach the variation in morphology (Fig. 4) is between pocket and sheltered type. The microtime scale studies available on pocket beaches showed that the erosion and accretion are corresponding to spring and neap tides during postmonsoon season (Hanamgond, 1988; Korakoppa, 1990).

The grain size characteristics studied are summarized as follows:

The sediments generally vary in their size from very fine to medium sand class. However, at the beach like Tilmathi (sheltered), size varies between coarse and very coarse. Mean size values of the foreshore show decreasing trend on either sides (Table 1) from the river mouth (Nayak, 1986) to Majali in the North and Karwar in the South. The grainsize values of the beach sediments also show variation with time (Table 2). Generally coarser material is seen during monsoon. Across the beach the mean grainsize values decreases from upper foreshore towards the lower foreshore.(Chavadi and Nayak, 1987). However at low tide a mixture of coarse and fine material is observed. Sediments of backshore were observed to be coarser in size than that of mid foreshore. Standard deviation (Table 3) and skewness values indicate marked spatial and temporal variations and follow closely the meansize. Better sorted (Fig. 5) and negatively skewed sediments are always associated with finer sediments (Chavadi and Nayak, 1987).

Table-1

Range of gain size parameter values of the sediments of studied beaches

S.No.	Beach Location	Mz	I	SKi	KG	Co%
1.	Polem	1.08 to 3.13	0.369 to 0.937	0.670 to -0.509	0.538 to 2.005	50 to 94
2.	Tilmathi	-0.66 to 0.84	0.247 to 0.658	0.869 to -0.565	0.553 to 2.131	6 to 29
3.	Majali	2.34 to 3.16	0.274 to 0.701	0.374 t0 -0.331	0.791 to 1.639	2 to 32
4.	Ramanath	1.32 to 2.96	0.263 to 0.733	0.461 to -0.436	0.558 to 1.998	o to10
5.	Sadashivgad	1.32 to 2.52	0.346 to 0.766	0.456 to -0.390	0.659 to 1.967	1 to 12
			KALI RIVER MOUTH			
6.	Kodibag	1.12 to 2.38	0.359 to 0.711	0.410 to -0.474	0.636 to 1.499	0 to 10
7.	Karwar	1.81 to 2.88	0.277 to 0.666	0.451 to -0.543	0.635 to 1.607	0 to 10
8.	Binge	2.12 to 2.96	0.191 to 0.599	0.334 to -0.499	0.776 to 2.869	8 to 56
9.	Shankrubag	2.58 to 3.14	0.217 to 0.693	0.572 to -0.366	0.751 to 1.994	9 to 44
10.	Arge	1.86 to 3.08	0.252 to 0.666	0.539 to -0.378	0.810 to 2.498	10 to 50

Table-2

Foreshore average of mean (Mz)
(Av. of H.T., M.T. and L.T.)

Months	Polem	Tilmathi	Majali	Ramanath	Sadashivgad		Kodibag	Karwar	Binge	Shankarbag	Arge
Dec	2.36	0.35	2.79	2.30	2.26		1.67	2.13	2.52	2.91	2.85
Jan	2.11	0.55	2.76	2.41	2.20	K	1.43	2.09	2.56	2.93	2.80
Feb	2.09	0.03	2.76	1.98	2.18	A L	1.87	2.14	2.62	2.90	2.72
Mar	1.87	0.24	2.65	2.29	2.07	I	1.64	2.07	2.70	2.88	2.77
Apr	1.85	0.08	2.61	2.24	2.02	R	1.40	2.00	2.50	2.78	2.77
May	1.84	0.02	2.52	2.28	2.02	I V	1.60	2.42	2.68	2.84	2.70
Jun	2.02	0.11	2.56	2.03	1.95	E	1.87	2.10	2.29	2.98	2.75
Jul	2.02	- 0.07	2.54	1.90	1.96	R	1.60	2.24	2.49	2.97	2.49
Aug	1.91	- 0.12	2.56	1.95	2.06	M	1.61	2.52	2.69	3.07	2.75
Sept	1.96	- 0.24	2.69	1.77	1.88	O U	1.88	2.43	2.64	2.96	2.36
Oct	1.98	0.11	2.80	2.57	2.24	T	2.01	2.38	2.60	3.03	3.03
Nov	152	0.23	2.81	2.60	1.71	H	1.72	2.14	2.67	2.88	2.93
Dec	2.36	0.43	2.93	2.50	2.13		1.94	2.38	2.72	3.03	3.01

The heavy minerals studied are summarized below :

Heavy minerals indentified along this coast are magntite, ilmenite, garnet, hornblende, tremolite, epidote, pyroxene, tourmaline, zircon, monazite, rutile, apatite, sphene and biotite. Of these magnetite and ilmenite are dominant and they occur in various geometric forms. The distribution of heavy minerals have been studied at different stretches along this coast. It is generally observed that heavy mineral concentration increases as the grainsize decreases. The heavy minerals are moreconcentrated in some of the pocket (Polem) and sheltered (Tilmathi) beaches (Nayak, 1986). The concentration is considerable in the sediments near river mouth. The weight percentage in all the fractions decreases on either side of the river mouth (Nayak and Chavadi, 1989). Seasonal studies carried out along this stretch showed the presence of relatively higher concentration during monsoon months (Fig. 6).

DISCUSSION

Seasonal changes in morphology, grain size characteristics and heavy mineral concentration of the beach reflects the changes in oceanographic conditions (Trask, 1956). The cyclic nature of beach changes associated with the monsoonal activities which control the weather and climate of this region is also observed. The erosional and accretional activities have been related to observed wave characteristics. During the south west monsoon the beach receives high energy waves from west and south west direction which causes increased erosional activity whereas during fair weather season the waves are comparatively less powerful, which facilitates accretion and development of the beach. The difference noticed in the time of commencement of erosion/accretion in different beaches may be due to their geographic orientation, geomorphology and bathymetry of the nearshore and the time of commencement of south west monsoon.

Apart from this, localised changes, deviating from general pattern are possible within the beaches and are controlled by the circulation patterns and longshore transport.

Generally, relatively coarse grained sediments which are comparatively poorly sorted and positively skewed are present during the monsoon season, associated with the erosional features of the beaches, due to the high and steep waves of the south west monsoon season (Veeryayya, 1972). Removal of large quantity of lighter minerals from the foreshore, helps in concentration of heavy minerals within the beach sediments during monsoon months. Minor variations in the above mentioned features in sediment characteristics reported (Chavadi and Nayak, 1987) may be attributed to the locally induced littoral currents, effect of small seasonal streams present at that location, concentration of carbonate in the sediments etc. The pocket beaches are always associated with strong longshore and rip currents due to their geomorphology. These currents in addition to waves received are responsible for the larger changes in these beaches. However the waves received by sheltered beaches are secondary in nature (Nayak, 1988). Therefore the changes in morphology and grainsize are comparatively smaller in magnitude here, though the trend of variation is similar to the general pattern. Studies carried out on pocket beaches with a smaller time scale during post monsoon showed their pattern of growth. The erosion and accretion periods here are associated with spring and neap tides respectively. The closer space (station) interval studies also showed circulation of major quantity of sediment within the pocket beach.

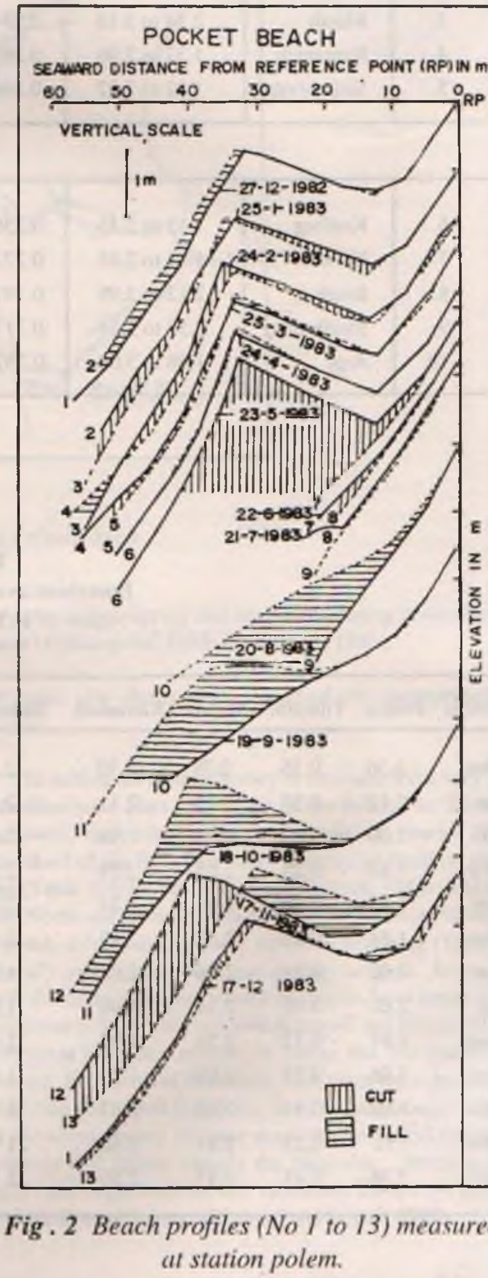

Fig . 2 Beach profiles (No 1 to 13) measured at station polem.

Table - 3

Foreshore Average of Standard Deviation (I)
(Av. of HT, MT and LT)

Months	Polem	Tilmathi	Majali	Ramanath	Sadashivgad	Kodibag	Karwar	Binge	Shankarbag	Arge
Dec	0.5457	0.5563	0.3487	0.4110	0.4210	0.5857	0.5477	0.4603	0.3384	0.3220
Jan	0.6060	0.4600	0.3947	0.3613	0.5227	0.5037	0.4853	0.3877	0.2763	0.3061
Feb	0.6587	0.6273	0.3533	0.6140	0.5437	0.4917	0.4857	0.3940	0.3316	0.3725
Mar	0.8200	0.5507	0.3800	0.4257	0.5090	0.5213	0.5117	0.3197	0.2383	0.3014
Apr	0.8103	0.5167	0.4533	0.4317	0.5273	0.5350	0.5500	0.4400	0.2592	0.323
May	0.8187	0.4400	0.4703	0.3563	0.5290	0.5350	0.4150	0.3347	0.2750	0.3685
Jun	0.5660	0.4613	0.4143	0.4147	0.4853	0.3787	0.5037	0.4167	0.3138	0.3775
Jul	0.5760	0.4853	0.3487	0.4390	0.4760	0.4390	0.4153	0.2760	0.3144	0.5246
Aug	0.5747	0.4497	0.3937	0.4227	0.4100	0.5043	0.4067	0.2443	0.3368	0.3478
Sept	0.6103	0.4060	0.3903	0.4020	0.5653	0.5439	0.4290	0.3553	0.2639	0.5603
Oct	0.6223	0.5510	0.4217	0.5593	0.4667	0.4717	0.5333	0.3540	0.3113	0.3467
Nov	0.6317	0.5930	0.4743	0.4623	0.5833	0.4417	0.5927	0.3010	0.4540	0.4168
Dec	0.5747	0.4387	0.4927	0.4163	0.5613	0.4100	0.5697	0.3680	0.3417	0.3515

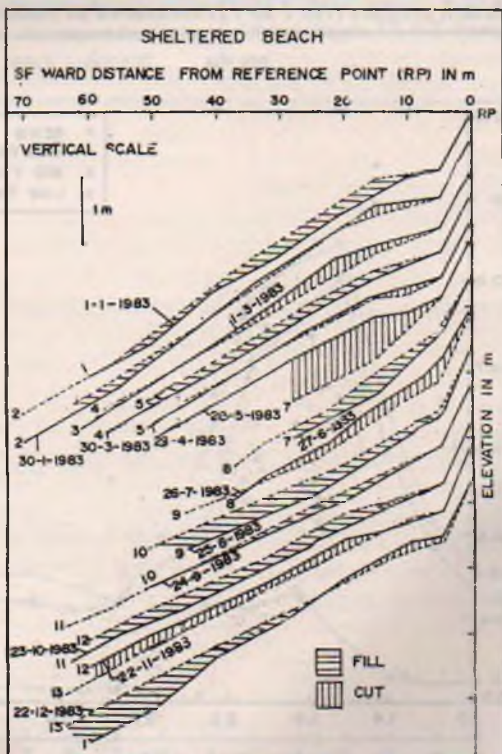

Fig. 3. Beach profiles (No 1 to 13) measured at station killebag.

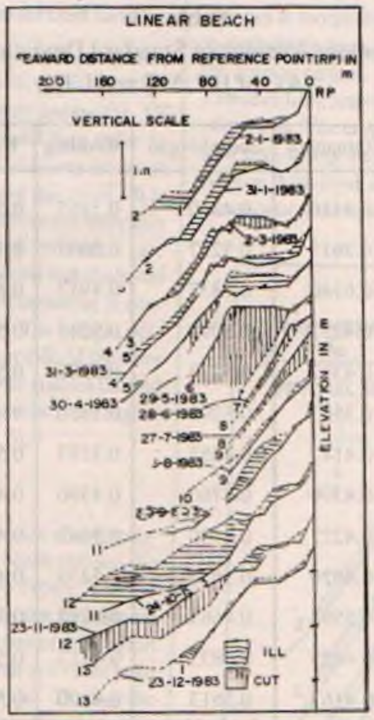

Fig. 4: Beach profiles (No 1 to 13) measured at station Arge.

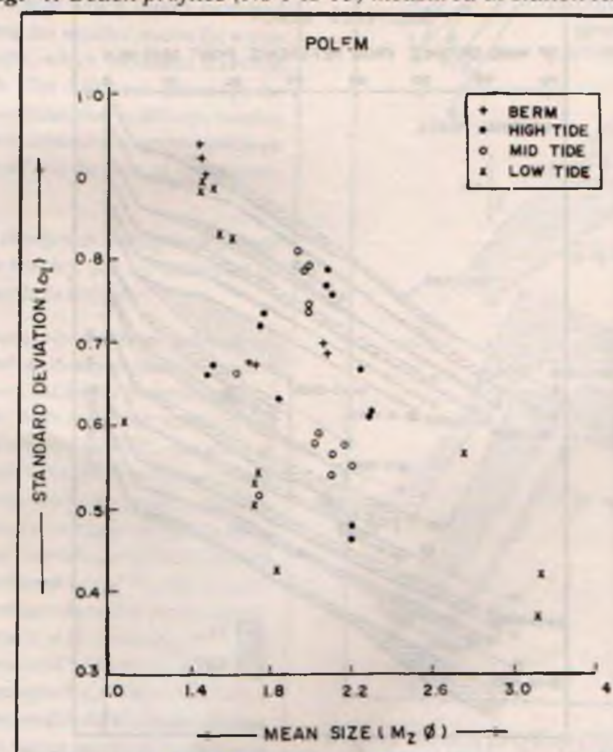

Fig. 5: Bivariant plot between mean size and standard deviation.

The sediments brought to the sea by all the four rivers namely Kalinadi, Gangavali, Aghanashini and Sharavati are redistributed depending on the specific gravity, size and shape and deposited in the nearshore zone of this stretch of the coast. The distribution of heavy minerals at the site of deposition is controlled by a variety of factors including destruction by wear and tear, stability of the minerals, density, grainsize, wave motion and energy of the depositional environment (Chaudhri and Grewal, 1985). The processes responsible for the distribution of heavy minerals near the river mouths are explained by Borreswara Rao and LaFond (1956). The density and grainsize of the heavy minerals, place them in the hard to move category of minerals. for the transportation of such minerals, current velocities greater than normal are required. The heavy minerals therefore are not hydrodynamically equal to the light minerals (Chaudhri and Grewal, 1985). The heavier minerals like magnetite, ilmenite, epidote, Zircon, Rutile, apatite etc. are deposited at the river mouth soon after the velocity is checked on entering the sea and are not carried seawards. Therefore the highest concentration of these minerals are at the mouth of the river (Kali and Sharavati). In contrast to these, minerals like hornblende, tremolite and biotite, because of their relatively lesser specific gravity behave to some extent as light minerals and do not settle in the high energy turbulent environment. Instead, they drift further on either sides along the coast as they can be moved shoreward under the crest but not seaward under the trough (May, 1973). This may be the reason for higher concentration of heavy minerals in the beach sediments.

The wave refraction studies carried out by Reddy and Varadachari (1972) showed general near linear southern drift along the west coast of India. Study carried out on littoral drift by Chavadi and Hegde (1989) at Gangavali river mouth showed seasonal reversal of current directon. Presence of shoals and coarser sediments slightly towards the southern side of the river mouths (at Kali and Sharavati) support drift towards south. However the heavy mineral distribution pattern indicates dispersal in other direction also. This may be due to the variation under the influence of littoral currents occasionally of opposing nature (Gouveia et al. 1976) and possible due to the cellular flows in the region north of river mouths as described by Veerayya and Pankajakshan (1988).

Continuous supply of meterial from the river develops a shoal. This might have acted as an obstruction and contributed to change the direction of littoral drift. The change in direction of sediment movement is indicated by the formation of a bar slightly towards northern side (Kali and Sharavati) of the river mouth (Nayak, 1986). This change in direction which is responsible for the formation of a bar might have reinforced northerly current (drift) along the beach.

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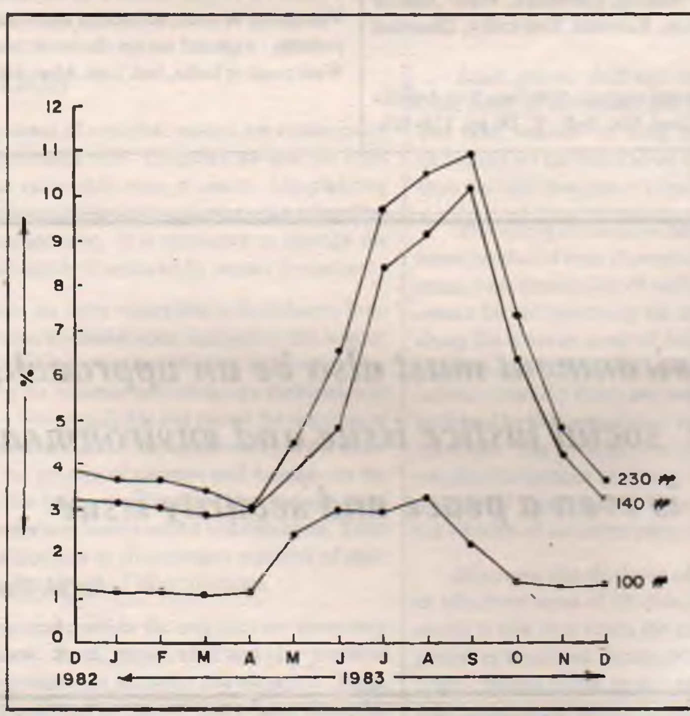

Fig. 6. Seasonal distribution of heavy minerals, Nagoond beach.

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Environment must also be an approach, is a social justice issue and environment is even a peace and security issue

-Ralph Torries