CHAPTER - V

SEDIMENT STUDIES

PROCEDURE

No microfaunal studies, especially those pertaining to the ecological controls can ~~not~~ be made in isolation, and due attention has to be paid to the nature of the sediments with which the shells of the micro-organisms occur along the coastline. Microfaunal diversity in respect of the relative frequency of the various genera and species, and their size and degree of fragility ~~are dependent~~ are dependent, of the tests, to some extent on their relationship with the nature of the associated sediments and the various processes by which those sediments have been distributed along the shoreline. The author has made an attempt to establish correlation between the nature of the coastal sediments and the associated

microfauna. With this purpose, representative samples of the shoreline sediments from the various coastal segments, were collected and studied. Samples were obtained from (1) Beach and coastal dune and (2) Tidal-flats environments, from appropriate sites.

For quantitative analysis of sands, 10 gm of sample were taken, soaked overnight in distilled water with 2 table spoons of dispersant (sodium hexametaphosphate/sodium carbonate). The sample was boiled and wet-sieved using 35,60 and 140 mesh. Particles retained in the sieves were dried and weighed to obtain the percentage of coarse, medium and fine grains. Each sample was accordingly classified into following three fractions :-

1. Coarse — Between 1.00 to .50 mm.
2. Medium — Between .50 to .25 mm.
3. Fine — Between .25 to .105 mm.
4. Silt — Less than .105 mm.

An identical procedure was followed for qualitative analysis. Instead of weighing the coarse, medium and fine sand fractions, they were examined and counted under the stereoscopic binocular microscope. Relative percentages of the contents of the three fractions were computed, and the modal compositions of the following constituents were obtained:-

1. Rock fragments,
2. Quartz,

3. Molluscan and other shell fragments,
4. Foraminifers,
5. Pellets (For Saurashtra only).

So far as the tidal muds are concernec, mostly they have been collected from the estuarine mouths of the various rivers. The samples were subjected to pipette analysis and the relative percentages of clay, silt and sand contents were worked out. For pipette analysis, the author followed the techniques by Folk (1974) and Friedman & Johnson (1982), as under :-

10 gm of tidal mud sample was weighed. The sample was then soaked with 5 gm of sodium hexametaphosphate which is used as dispersal agent. The sample was placed in a graduated cylinder with 1000 ml of distilled water, was stirred vigorously and then allowed to stand overnight in order to be sure that flocculation did not occur. The mixture was kept at room temperature. After 24 hours, next day the mixture was stirred with a plunger until the homogeneity was achieved. Before drawing the initial aliquot the mixture was first allowed to settle for exactly 60 seconds. The initial aliquot was removed from the cylinder using a 20 ml pipette, which was inserted gently avoiding stirring of the suspension. The mixture drawn in the pipette was then ~~em/~~ emptied into a pre-weighed beaker. A little distilled water was also drawn out to rinse the pipette, this rinse water was also drained into the same aliquot beaker. In a similar fashion the above steps were continued to obtain aliquots at specific intervals and different depth as under:-

		TIME	DEPTH
(A)	After first settlement	20 sec.	20 cm.
		1 min. 33 sec.	20 cm.
(B)	After Restirring	1 min. 33 sec.	10 cm.
		3 min. 06 sec.	10 cm.
		6 min. 12 sec.	10 cm.
		24 min. 48 sec.	10 cm.
		49 min. 36 sec.	5 cm.
		3 hrs. 18 min.	5 cm.
		13 hrs. 12 min.	5 cm.
		52 hrs. 42 min.	5 cm.

The aliquots were then dried in the oven at about 90° C and were weighed. The weight of the dispersant was accounted for, by adding 1/50 of the total weight of the dispersant to the beaker weight for each aliquot. Each fraction was multiplied by 50 and substracted by successive values. The differences of weights of phi sizes were recorded. The percentage of sand in the sample was calculated by using the formula:-

$$\frac{100\ S}{(S + F)}$$

S = Weight of sand caught on the 4Ø (62 micron) screen.

F = 50 times of the first pipette sample (i.e. total amount of mud in cylinder).

Cumulative percentage of the sample was obtained by using the formula :-

$$\text{Cumulative } \% = \frac{100\ (S + F - P)}{S + F}$$

P = 50 times of the quantity obtained by each later pipette sample.

Using the cumulative percentage data, weight percentages of sand, silt and clay were obtained. The sand fractions were further examined under stereoscopic microscope for broad visual appraisal of their nature.

The various data thus obtained have been compiled in Table V.1 a & b and 2 a & b and plotted on appropriate diagrams. (Fig. V.1, 2, 3 & 4). Preliminary heavy mineral studies, especially for the Mainland Gujarat, were also undertaken with a view to understand the provenance of the sediments as also for understanding the pattern of littoral drift or longshore drift responsible for their transport.
(Information on textural parameters was collated by the author from other sources (Hardas & Patel, 1982; Jocttun, 1982; Hardas, personal communication). For details, Appencix 'A' may be referred.)

GENERAL ASPECTS

The coastal sediments of Saurashtra and Mainland Gujarat are strikingly different from each other. While those of Saurashtra are dominantly calcareous, the Mainland coastal sediments are comparatively rich in terrigenous, non-carbonate constituents. The sediment diversity observed from one end to other end of the

Table V.1 (b) Sediment characteristics of Saurashtra coast (Tidal mud).

Coast	Locality	Percentage composition		
		Sand	Silt	Clay
Jamnagar coast	Rozimata temple	45.6	35.7	18.7
Dwarka coast	a. Near Dwarka	6.6	49.8	43.6
	b. Near Charakla	70.5	17.5	12.0
Porbandar coast	Near Harsidhmata	3.5	42.5	54.0
Delvada coast	Near Diu	3.0	38.8	58.2
Bhavnagar coast	Port victor	2.0	55.3	42.7

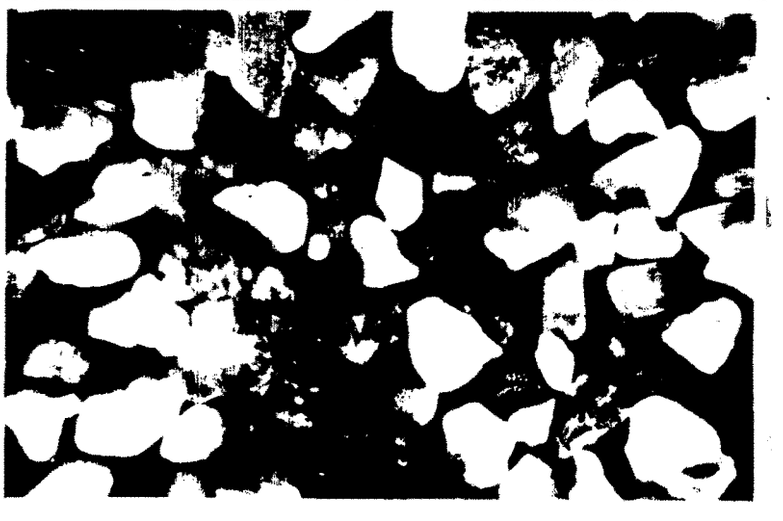
Table V-2 (b) : Sediment Characteristics of Mainland Coast (Tidal mud).

COAST		LOCALITY	Percentage Composition		
			Sand	Silt	Clay
Cambay-Dahej Coast	a)	Roha-Talav	0.4	52.0	47.6
	b)	Sabarmati river Mouth-Tarakpur creek	0.4	59.3	40.3
	c)	Mahi river Mouth-right bank Dhuvaran	39.9	47.4	12.7
	d)	Mahi river Mouth left bank -Kotiakhar	2.6	84.6	12.8
	e)	Dhadhar river Mouth Kavibandar	17.2	61.3	21.5
	f)	Dahej bandar Ghugharia creek	12.5	67.1	20.4
Hansot-Hajira Coast	a)	Kim river Mouth-Hansot	0.50	37.1	62.40
	b)	Tapi river Mouth-Sunvali	1.5	57.5	40.9
Dumas-Tithal Coast		Tidal flat near Dandi	2.98	47.95	49.07
Tithal-Umbargaon Coast	a)	Near Bhaglawada	17.0	55.0	28.0

study area provides very valuable information on the coastal environments and the processes operating in the offshore, shoreline and onshore areas in the various coastal segments. The sediments along the Jamnagar and Okha coast within the Gulf of Kutch are dominantly muddy; wherever the beach sands are encountered, they are rich in coraline sands. (Plate V. 1 & 2). In contrast, the beach and dune sands along the western and south-western coast of Saurashtra, though essentially calcareous, are seen to consist of foraminiferal tests and molluscan shell fragments (Plates V.1, 2, 3, 4, 5 & 6). The grains show a high degree of abrasion. The sediments of southern coast of Saurashtra are almost identical to those of west and south west coast, but when traced eastward with increasing nearness of the Gulf of Cambay, the overall carbonate percentage decreases. (Plate V.7). The coastal segments overlooking the Gulf of Cambay show an almost abrupt change, and are seen to comprise sands (wherever present) made up of terrigenous constituents (grains of rocks, quartz and some other minerals). (Plate V.8, 9 & 10). By and large, the sediments right up to the mouth of Narmada on the Gujarat Mainland are muddy and silty. Only after crossing Narmada the coastline further south shows a progressive increase of beach sands. (Plate V.11, 12,13). These sands contain a minor proportion of shell fragments and are seen to consist mostly of grains of basalt and other rocks, quartz and minerals derived from the Deccan trap. Even on the Mainland coast, the nature of coastal sediments in terms of constituents and textural characteristics show a marked change from north to south.

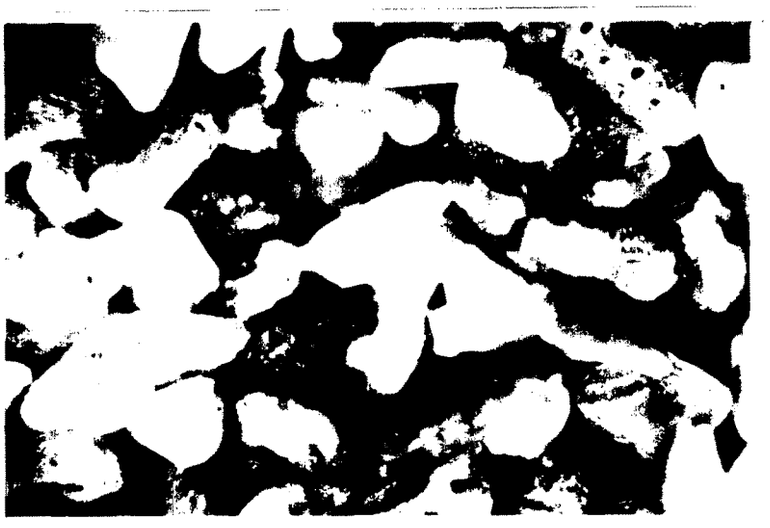
PLATE-V. 1 & 2.

1. Beach sand : Jamnagar coast(segment I) x 22.



2. Beach sand : Okha coast (segment II) x 22.

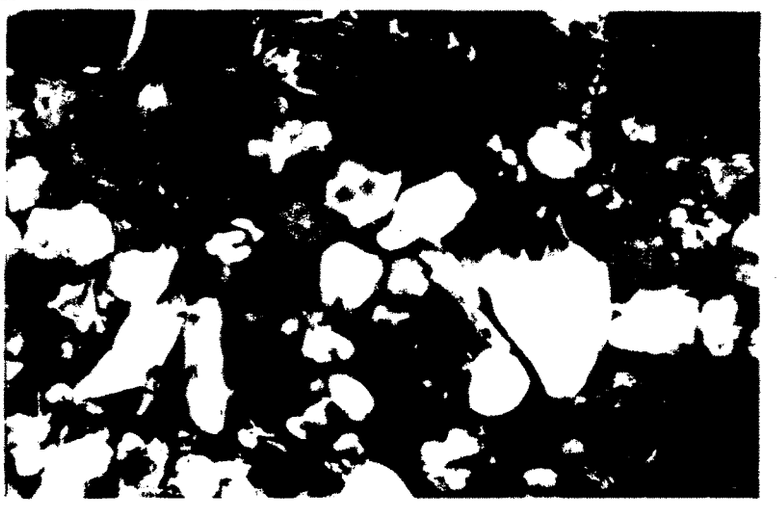
PLATE-V. 3 & 4.



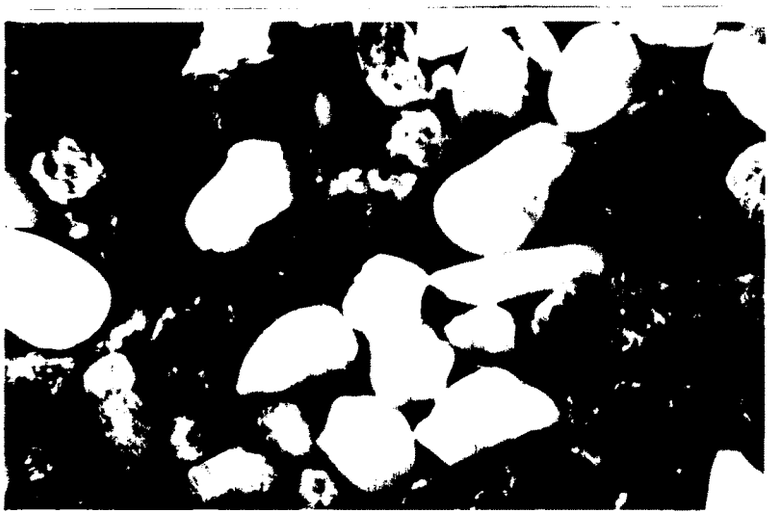
3. Beach sand : Dwarka coast (segment III) x 22.

4. Beach sand : Porbandar coast (segment IX) x 22.

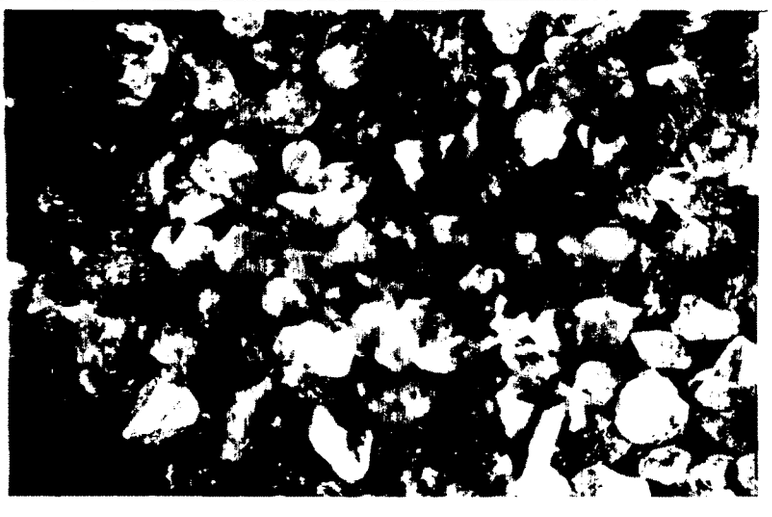
5. Beach sand : Diu coast (segment V) x 22.



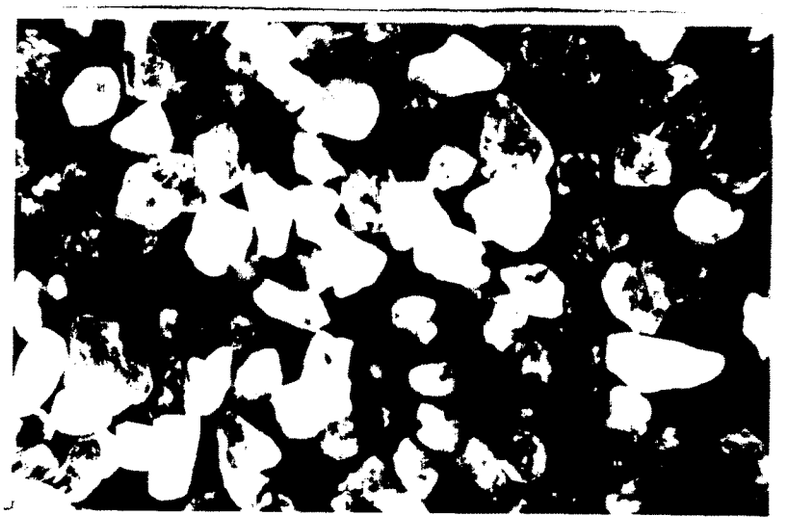
6. Beach sand : Mahuva coast (segment V) x 22.



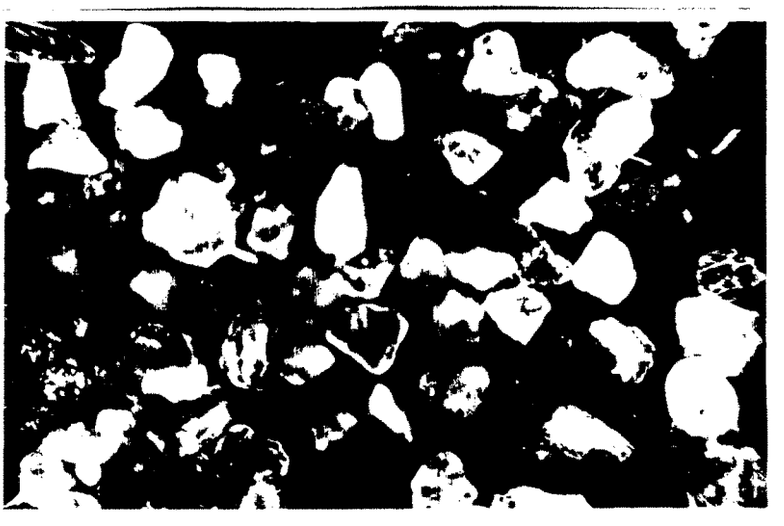
7. Beach sand : Bhavnagar coast (segment VI) x 22.



8. Beach sand : Dahej coast (segment VII) x 22.

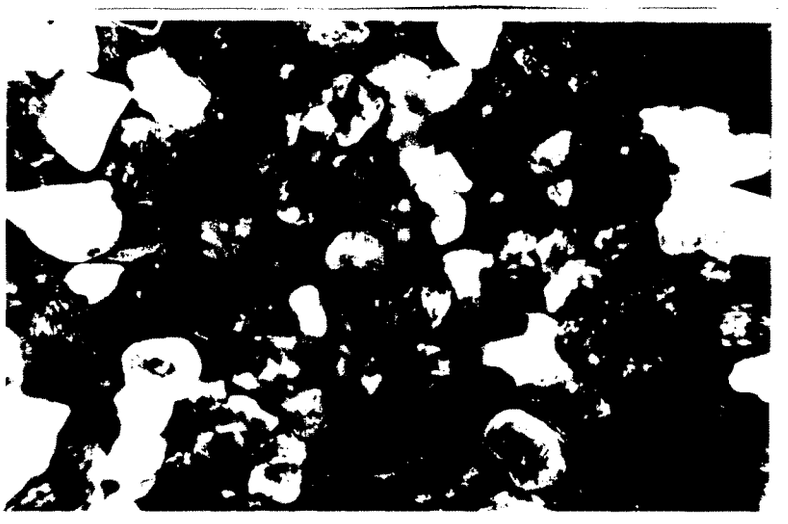


9. Beach sand : Dandi coast (segment VIII) x 22.

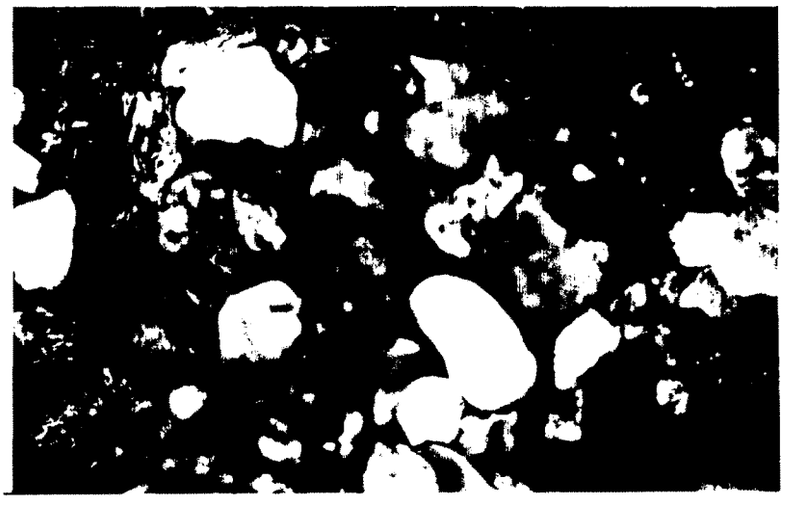


10. Beach sand : Hazira coast (segment VIII) x 22.

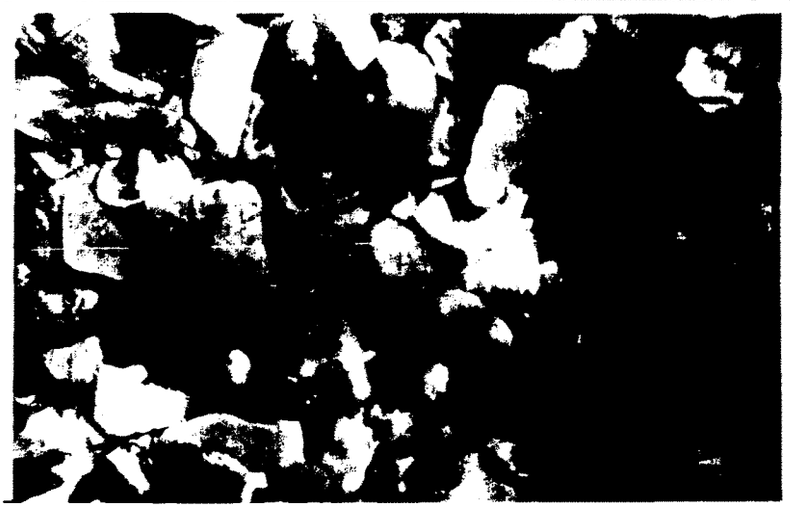
PLATE-V. 11 & 12.



11. Beach sand : Dandi coast (segment IX) x 22.



12. Beach sand : Tithal coast (segment IX) x 22.



Beach sand : Umbargaon coast (segment X) x 22.

HEAVY MINERAL DISTRIBUTION

The available data on heavy mineral content of the coastal sediments provide quite a few evidences of the sediment movement patterns along the shoreline, especially in the Gulf of Cambay and along the Mainland coast. The author has collected the information on 'heavies' from the works of Hardas & Patel (1982), Joottun (1982). Some of her samples were analysed by Hardas and data provided (personal communication). Salient points of the heavy mineral distribution, relevant to the present study are as under :

(1) Heavy mineral content of the sediments along the Saurashtra coast, upto Diu Island in the south is negligible. Nearing the Gulf of Cambay, some heavies do appear. Of these the most dominant 'heavy' is augite. Other minerals are hornblende, garnet, biotite, zoisite, muscovite, zircon, staurolite, andalusite, sporadic kyanite and tourmaline. Augite tends to decrease towards Bhavnagar (mouth of the gulf).

(2) On the Mainland coast augite is rather scarce in the northern part, but it steadily increases southward. Other heavies continue to be present but tend to decrease southward. Ilmenite, however, is present all throughout the Mainland coast.

It is worth mentioning that the sediments of the Gulf of Cambay, typically show a decreased augite content as against

increase in zircon, garnet, staurolite, etc.

Augite has been derived from the basalts. It is not unlikely that most of the augite of south Saurashtra coast, has drifted from the Mainland coast, by littoral currents. While the source of the other heavies, is the metamorphic and granite terrain of north and central Gujarat, these have obviously been brought by the major rivers like Sabarmati, Mahi and Narmada. The presence of the 'heavies' related to the Precambrian provenance, in the southern parts of the Mainland coast, is attributed to the longshore transport of the gulf sediments by outflowing tidal currents.

The distribution pattern of the heavy minerals conforms to the other evidences which reflect the transport and accumulation of coastal sediments.