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THE OCCURRENCE OF MUD ON A SANDY POCKET BEACH NEAR ANJARLE, COASTAL MAHARASHTRA

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ABSTRACT : Many sandy beaches have started showing preliminary signs of mud deposition since the last decade on the Konkan coast of Maharashtra. Although it is not always easy to recognise the cause and source of this mud. a distinct erosion and accretion cycle of sedimentation and minor fluctuation in sea level may be responsible for this recent appearence of mud on Konkan coast.

This paper discusses the nature and appearance of mud on an isolated beach of coastal Maharashtra. The work is based purely on field observations and relevent analysis in the laboratory. The finding of the work indicates the relevance and importance of mud occurrence on Maharashtra coast.

The beach is a typical sandy pocket beach characterised by surface and subsurface mud along the shore face and the superficial mud in the tidal channel. The mud in the tidal channel owe its existence to flood and ebb currents and that on the shore face to offshore onshore movements of waves. The frequency of mud chunks, the morphology of mud sections and textural and chemical composition of mud appear to be governed by these basic differences in the depositional processes. The fresh water flow through the channel is insignificant for most of the year and does not influence the flocullation, setting and movement of clay through the channel.

The subsurface mud is scoured by high energy monsoon waves which consequently moves to backshore. The beach is then covered by a thin carpet of mud by the end of monsoon. The shoreface is covered by thick mud. The mud layer thins in the direction of backshore. The mud on the upper beach dries out faster and leads to the formation of mud balls.

KEY WORDS : Mud. mud balls, dessication and cracking, mud chunks, channel mud, sea level fluctuation, erosion - accretion cycle.

INTRODUCTION :

The occurrence and appearence of mud was not very common along the Konkan coast of Maharashtra until recently. Many beaches such as beach at Navapur (19° 46'), Revas (18° 49'), Revdanda (18° 32'), Shrivardhan (18° 03') and Kelshi (17° 56') have however started showing signs of mud deposition since last decade or so (Awasthi 1990, Shrikhande 1991, Karlekar 1993 and Kale et al 1993). It is not always easy to trace the source of this mud. many sources such as river flow, dredging in the nearshore areas, reclaimation of bays and scouring of continental shelf are normally suggested. The very existence of mud on intertidal beaches and in the tidal inlets suggests local fluctuation of ses level, variation in climatic conditions and decrease in tidal component (Wells J.T. 1981)The continued and uninterrupted mud deposition may cause

shoaling in unwanted places particularly in harbours and tidal channels.

The mud on Konkan coast has started appearing in different coastal settings. Moreover the mud areas are not fixed and rigid. The mud appears to move on the beaches seasonally. At many places the mud on the beaches is overlain by sands in fair weather and is scoured and resuspended in stormy monsoon season. It is found to settle at different depths alternated with sands and shingles. The mud on beaches dries in postmonsoon, dessication cracks are developed. mud chunks are produced and these chunks are eventually transformed in mud balls by rolling action (Kale et al 1993). The armouring of mud balls by shells and shingles reported by Kale et al (1993) is however not very common and can be seen only at a few places like Revdanda (18° 32') and Kelshi (17° 56').

A distinct erosion-accretion cycly leading to scouring of beach in mosoon and filling in fair weather, supplemeted with minor fall of sea level and scouring of nearshore zone may be responsible for recent appearence of mud on Konkan beaches.

THE FIELD SITE :

The beache under study (Fig. 1) is a small inconspicuons , remote beach on Konkan coast (17° 52'N & 73° 05'E) The total length of the curved shoreline of the beach is 1140, m. A small tidal inlet oriented north south occupies the southern part of the beach. Mud is restricted to the lower part of the beach fringing the sea and in the tidal channel to the south (Table 1) The surface and subsurface mud, mud chunks, and mud balls were found to be totally undisturbed and ideal for study.

LOCATION MAP

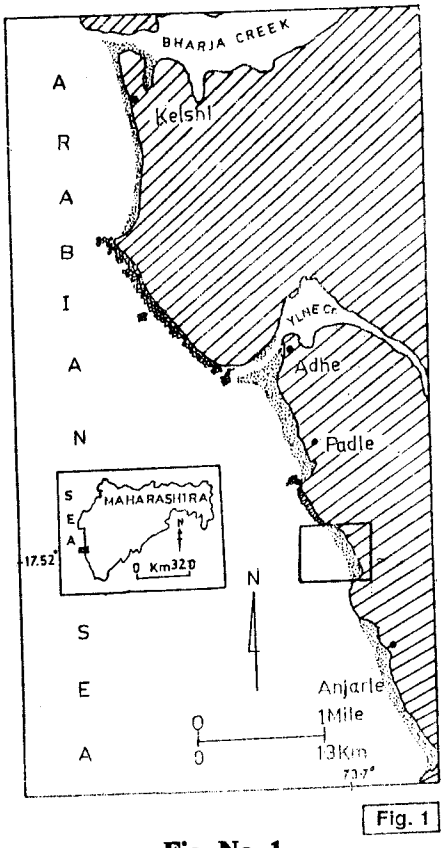

Fig. No. 1

TABLE -1

Basic data on study beach	
1. Length of the curved shore	: 1140m.
2. Beach width (North)	: 120 m.
3. Beach width (Middle)	: 156 m.
4. Beach width (South)	: 192m.
5. Beach deposits	: Fine sand and clay
6. Wave approach	: South westerly (monsoon) Westerly (Fairweather)
7.Mud	: Beach surface Beach subsurrace (30 cm deep) Tidal channel

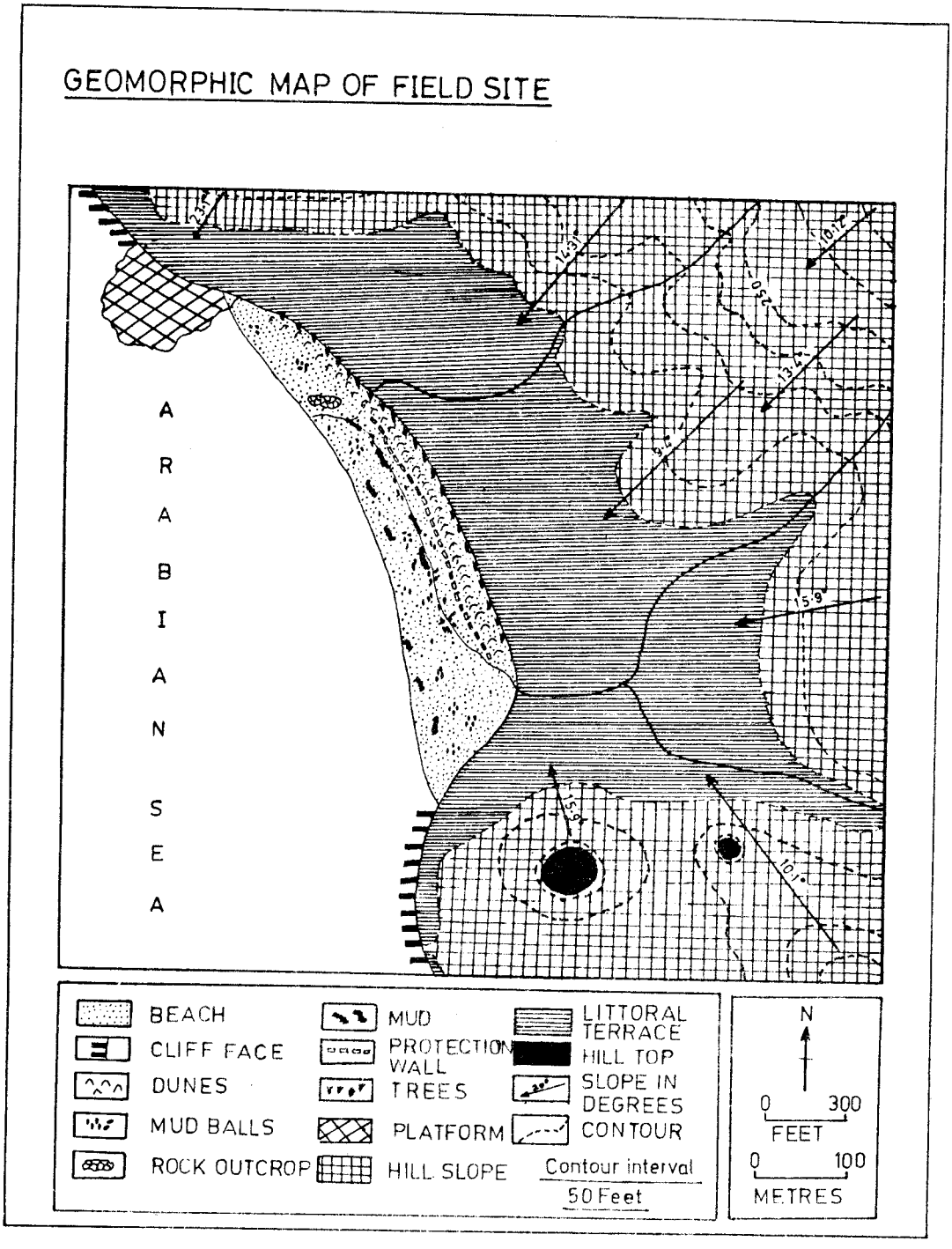
GEOMORPHIC MAP OF FIELD SITE
ARABIAN SEA
BEACH
CLIFF FACE
DUNES
MUD BALLS
ROCK OUTCROP
MUD
PROTECTION WALL
TREES
PLATFORM
HILL SLOPE
LITTORAL TERRACE
HILL TOP
SLOPE IN DEGREES
CONTOUR
Contour interval
50 Feet
N
0 300
FEET
0 100
METRES

Fig.No. 2

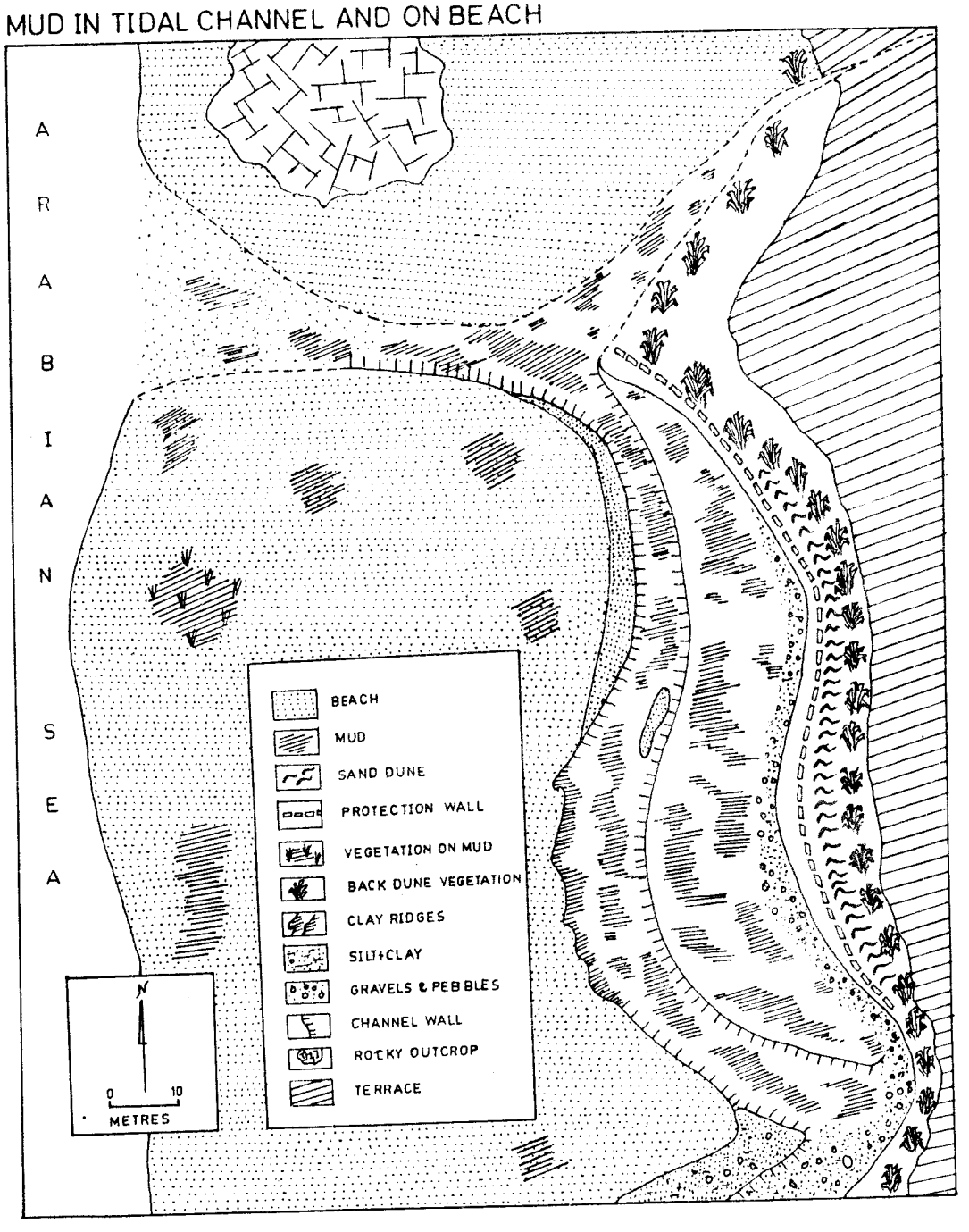
MUD IN TIDAL CHANNEL AND ON BEACH
ARABIAN SEA
BEACH
MUD
SAND DUNE
PROTECTION WALL
VEGETATION ON MUD
BACK DUNE VEGETATION
CLAY RIDGES
SILT+CLAY
GRAVELS & PEBBLES
CHANNEL WALL
ROCKY OUTCROP
TERRACE
N
0
10
METRES

Fig.No. 3

THE METHOD OF INVESTIGATION :

This work is based on sample and field study carried out in the area in premonsoon. monsoon and post monsoon season. The surface and subsurface mud was observed, sampled analysed for textural, chemical and mineralogical composition, The field channel was surveyed in detail and the movement of clay through flood and ebb was studied.

THE MUD, MUD CHUNKS, AND MUD BALLS :

The region around the beach is principally a littoral terrace bounded by hill slopes which provide material that moves downslope. The littoral terrace is a very extensive plain and slopes seaward at an angle of 1.5. The average width of terrace is about 500m. The tidal inlet to the south of the beach is 684 m long. The tidal flow operates through the inlet to a distance of 210 m at every flood and ebb. Upper reaches of the tidal inlet are 50 m wide. The lower reaches are relatively narrow, where the width of the entarance is not more than 27 m.

The bed of the tidal channel is covered by 10 to 30 cm thick mud deposits, especially along the right bank of the channel (Fig. 3). The left bank of the channel is steeper and higher. The mud is only exposed on the lower beach. On upper beach it is concealed under the surface sand. At the limit of tidal penetration thick mud appears only in the center of the channel and both the banks are out in silt and sand. The surface and subsurface mud on the beach appears on the left bank of the channel (Fig. 4). The tidal flow is confined to the channel near the left bank of the channel. The mud in the channel is thick, sticky and compact. It is not easily scoured in monsoons.

The mud on the lower beach dries due to dessication in postmonsoon and big mud chunks are developed. The primary cracks are 2 to 4 cm wide and 4 to 6 cm deep. The chunks are triangular to polygonal in shape. The irregular chunks are comparatively few in number. Most of the primary chunks have a surface area between 70 sq cm and 500 sq cm It is found that the primary cracks run more or less parallel to each other and are connected by secondary network of cracks. Chunks in the pre monsoon period were 15 to 20 cm thick.

The cracks widen and chunks are excavated in post monsoon by swash backwash movement. The rolling by swash backwash currents leads to the formation of mud balls and their armouring by beach deposits (Kale et al 1993). The mud in the tidal channel is always sticky and moist and does not crack due to lack of dessication.

The water samples collected in pre monsoon, monsoon and post monsoon season from the beach, the tidal channel and the breaker zone show that breakers are more turbid in monsoon at low as well as high tide (Table 2). Similarly the tidal water in the channel has more concentration of suspended sediments which eventually settle on the chnnel bed.

TABLE 2

Suspended sediment concentration (Mg/L)

Season	Tide	beach	Tidal Channel	Breakers
Pre monsoon	LT	198	265	350
	HT	290	450	390
Monsoon	LT	320	560	1324
	HT	346	540	1714
Post monsson	LT	160	432	372
	HT	220	500	790

(LT : Low tide, HT : High tide)

THE TEXTURAL, CHEMICAL AND MINERAL COMPOSITION OF MUD :

The infra red spectroscopic studies of the mud samples collected from the study area clearly

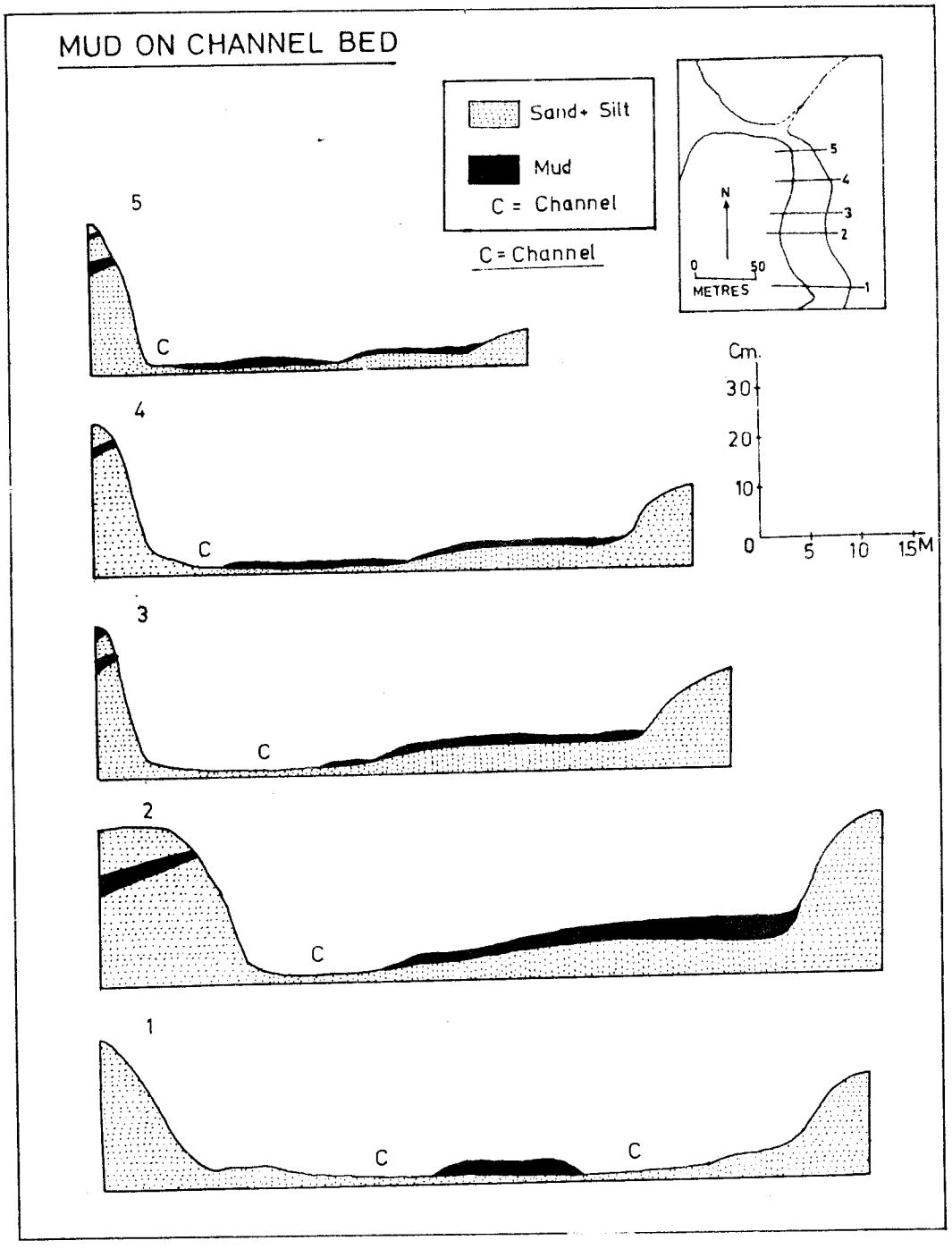
MUD ON CHANNEL BED
Sand+ Silt
Mud
C = Channel
C = Channel
N
0 50
METRES
5
4
3
2
1
Cm.
30
20
10
0
5
10
15M
C

Fig. No. 4

indicate the predominance of montmorillionite group of clays in surface, subsurface and tidal channel mud (Table 3).

TABLE 3

Minerology of the Mud (IR Spectroscopic studies)		
Beach surface mud	:	Montmorillionite-Kaolinite - Illite (3: 2: 1)
Subsurface mud	:	Montmorillionite-Kaolinite - Illite (3:1:1)
Tidal channel mud	:	Montmorillionite-Kaolinte - Illite (3:2:1)

The shrinkage of clays due to dessication is mainly a result of this predominance of montmorillionites in the mud. The bulk density of the mud varies from 1.01 to 1.05 gr/cm3. The mud at the head of the channel is relatively denser (Table 4) and more silty clayey. The subsurface mud also shows more proportion of silt and clay. The organic carbon in the mud samples ranges between 1.79% to 1.95% the average being 1.88% (Table 5). Sio2 is a major constituent of muds and it is about 31%. The clay in samples is only 0.67%

TABLE 5

Range of Constituents			
Constituent	**Max-Min**	**Mean**	**Std. Dev.**
Water content	41.38-14.78	30.79	9.34
Organic carbon	1.95-1.79	1.88	00.006
$CaCo_3$	56.30-25.90	46.23	09.38
Coarse sand	67.80-27.84	55.15	12.56
Fine sand	10.21-06.75	08.08	01.12
Silt	64.77-23.99	35.57	13.49
Clay	01.07-00.33	00.67	00.22
Potassium	00.-12-0.002	00.007	00.002
Sodium	00.28-00.05	00.18	00.07
Aluminium oxide	17.31-14.48	16.29	00.87
Silicon oxide	32.49-28.04	30.77	01.38
FeO	01.52-1.16	-1.42	00.11

All values in percentage.

TABLE 4

Textural, Chemical and Minerological Analysis of Mud

	Tidal channel			Beach		
	Head	**Left bank**	**Rt bank**	**Mouth**	**Surface**	**Subsurface**
Water content	41.37	36.73	20.41	28.39	14.78	39.60
Organic carbon	1.91	1.84	1.85	1.80	1.96	1.96
Bulk density	1.05	1.02	1.02	1.01	1.01	1.02
$CaCo_3$	56.30	54.40	41.40	48.50	25.90	47.31
Coarse sand	27.84	66.11	61.33	58.51	67.71	51.73
Fine sand	6.83	7.63	10.11	8.98	7.97	6.76
Silt	64.77	25.18	27.86	31.75	23.99	40.98
Clay	00.56	01.07	00.70	00.75	00.33	00.53
Potassium oxide	00.012	00.007	00.007	00.007	00.002	00.012
Sodium oxide	00.27	00.14	00.18	00.17	00.05	00.28
Aluminium oxide	14.48	16.96	17.31	16.31	15.92	16.56
Silicon oxide	32.49	31.40	29.52	28.04	31.40	31.03
FeO	01.40	01.44	01.52	01.52	01.48	01.16

All values in percentage except bulk density. Bulk density in g/cm^3.

FINDINGS :

It is apparent from the above discussion that the beach near Anjarle is predominantlly a sandy beach covered seasonally by mud deposits. The shoreface and nearshore zones have a thick cover of mud (up to 30 cm). The upper beach has a thin cover of mud which is not more than 10 to 15 cm thick. The high concentration of suspended matter in monsoon waves and breakers in general suggest that the source of the mud lies in the near vicinity of beach. The bulk density and the variation theirin points to the fact that the dense sediment is removed from bottom of nearby shelf by waves and currents (Wells 1981)

A distinct erosion and accretion cycle can be envisaged which is responsible for excavation of subsurface mud, its cracking and eventual burrying under sand in fair weather. A minor fall in sea level may be responsible for the removal of mud from nearshore areas and its movement on beach with swash and backwash. Mineralogical and textural analysis of mud indicates that the mud depostited in variety of topographic positions on beach and the subsurface areas are identical in nature. Montmorillionite clay is a major constituent of the mud followed by kaolinite and illite.

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