

## Mud Beach at Rewas

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### Abstract

*The sediment body developed at Rewas is a result of specific wave and tide dynamics in the area. From the morphological characteristics, the sediment body appears to be a drift aligned feature. Its lower shore face is covered by thick mud deposits and the back beach is cordoned by sandy deposits. It exhibits a pattern of sedimentary facies suggesting the complex depositional dynamics of a macro tidal, storm wave environment with predominantly free sediment transport.*

### Key Words

*Mudflats, Fossil Mangrove Roots, Buried Tidal Channel, Scouring of Beach, Tidal Microfeatures.*

### Study Area

The intertidal beach at Rewas stretches from 18°47' N to 18°49' N lat. and 72°54' E to 73°56' E long. (Fig. 1). The tidal range in the area is 3.5 m. The total area of the beach is 13.22 sq. km. The length is 7 km and the average width is 2.3 km. The distal end of the beach runs for about 1.87 m into the sea and turns abruptly towards the creek. Here it takes the form of a spit. It is developed in downdrift direction and shows moderate convexity and curvature towards the entrance of Dharamtar creek (Fig. 2).

The tides in the Dharamtar creek area are of mixed semidiurnal type, characterised by two unequal, high and low waters occurring each tidal day (NIO Report 1985). The spring tide range at Rewas is 5.08 m

and at Nagothane 50 km. upstream it is 3.35 m. The creek area experiences a macro tidal environment upto Ganeshpuri located 3.97 km upstream of Rewas. The tidal range is as low as 1.04 m at Rewas, and as high as 1.90 m at Nagothane.

There is an increase of 30 cm in the tidal range during spring at Dharamtar. This is due to the piling up of tidal water, caused by the narrowing of the channel upstream of Dharamtar. The high tide at Rewas precedes the high tide at Apollo Bunder (Bombay) by only 3 minutes.

Considering the morphology of the creek, the tidal influence, sediment transport, its dispersion and flushing time, any material released here requires 31 tidal cycles for flushing out completely during neap tide, while only 3 tidal cycles are required during spring (NIO 1985).

The villages bordering the beach are Mandve, Milkatkar, Telavne, Bagdande, Navakhar and Rewas. Of these Navakhar

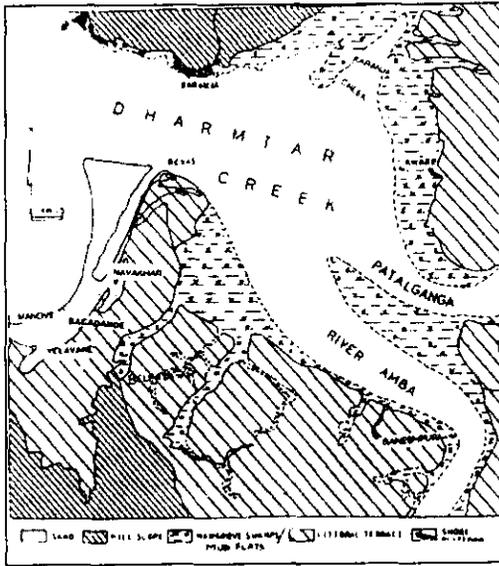


Fig. 1 Field Site

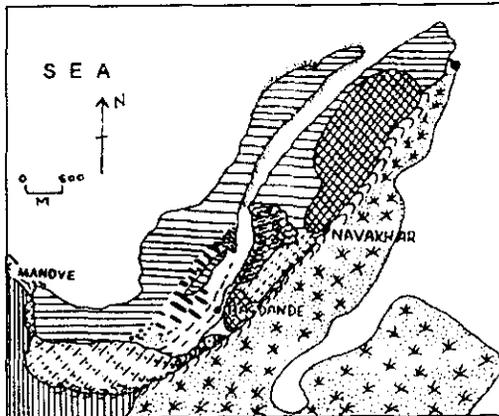


Fig. 2 Geomorphic Map of Rewas Beach

and Bagdande are the villages that are very close to high water line (Fig. 1) and are affected by slight changes in water level in monsoon. River Amba joins the sea through Dharamtar creek. River Amba is the main source of silt, sand and clay. The clay

deposited near the distal end of the beach is brought by the river through Dharamtar Creek. Due to thick deposition of silt, clay and mud in the sheltered areas of Creek, it is dominated by mangrove swamps.

A geomorphic map prepared in field in September 1990 (Fig. 2) shows that areas near Kaproli and Mandve are wide rocky platforms, which are undergoing severe erosion. The beach near Navakhar is accreting due to littoral drift. The backshore is a zone of low sand dunes that are backed by extensive mudflats and thick mangrove swamps.

### Methodology

To understand the depositional dynamics of the inter tidal beach at Rewas, field studies were carried out in September 1990, December 1990, April 1992, April 1993 and August 1994 representative of monsoon season, post monsoon and fair weather in the area. A change in bedform and sedimentary facies was observed in both seasons at high and low tides.

About 13 samples were collected from the beach to study the textural properties of the sediments (Fig. 3). Variety of bedforms were identified and measured. The study of mud beach was carried out in all seasons. The thickness of sandy clay deposits on beach was measured. Grain size analysis of sediments was carried out by dry sieving.

### Beach Morphodynamics

The field visits in pre-monsoon, monsoon and post-monsoon showed a sharp seasonal change in beach morphology and beach deposits at Rewas.

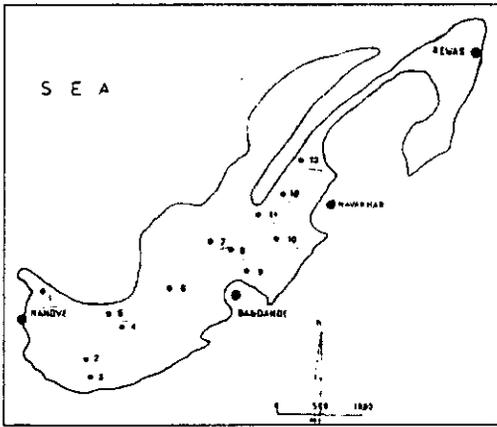


Fig. 3 Sample Sites

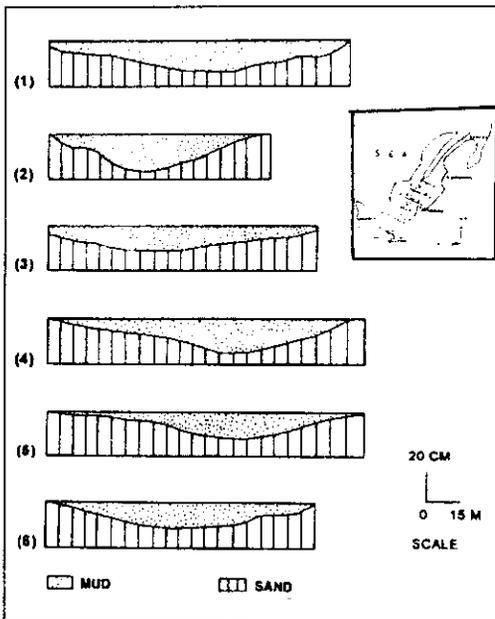


Fig. 4 Mud in the Buried Channel

It was found that in monsoon, scouring of upper beach as well as the backshore, is a major phenomenon. The waves reach to the nearby villages, breaching the protection walls, fields and tidal channels. A large

amount of sandy silty material moves to offshore and nearshore zone. Lower beach is left with thick deposition of fine sand. In post monsoon, lower beach starts eroding and underlying mud is exposed. Mud slowly desiccates, cracks and mud chunks are developed. The chunks roll in swash and backwash. Elongated mud balls are developed and deposited on backshore in pre monsoon period. A large area covered by mud on lower beach however remains intact and does not easily desiccate as it is moist and relatively more cohesive. Field observations indicated that the mud balls, are armored by shells and sands but the armoring is not very conspicuous, as seen by Kale et. al. (1993) on the beach at Revadanda which is located only 25 Km. south of Rewas. The mud balls are also small in size and occur less frequently, meaning thereby that the mud here does not easily desiccate, and crack.

It was observed that the mud contains numerous fossil roots and rotten trunks of mangroves. The roots are firmly embedded within clay particles. In addition to the fossil roots, mud also contains many marine fossils of oyster shells, snails and mollusc. A fossil mangrove root from the area when dated by radiocarbon dating gave a data of  $600 \pm 80$  YBP (B.S.I.P.I.S. 1051, June 1993).

Study of subsurface deposits on the beach revealed the existence of a buried, paleo tidal channel, roughly in the centre of the beach. The core samples and penetration of measuring stick into deposits suggested that this channel is filled by silty to clayey deposits. Upper layer of about 8 to 20 cm thickness is a layer of fine to medium sand. Alignment of this buried channel is parallel to present day low water line. The strong

tidal currents have helped in keeping the present day portion of the channel free from silting. The upper shallower sections of the channel are filled by clayey deposits (Fig. 4).

Core sampling carried out at various sites (Fig. 4) indicated mud up to a depth of 20 to 30 cm below present beach surface. The depth when plotted, clearly brings out the existence of a shallow tidal channel in mud now filled by sand. It is to be noted that the buried channel shows perfect orientation north eastwards. One can also recognise its connection with the mouth of tidal channel at Yelwane. The presence of mud at 30 cm depth at this distance, parallel to present day low water line may also suggest that this was previous shoreface.

The mud flats on backshore are also parallel to this buried channel. The powerful tidal currents have helped in keeping the mouth of this buried channel free from any silting.

The existence of buried channel and its perfect alignment with modern low water line suggests heavy accretion of sediments and progradation of beach in early Holocene.

The main source of sediments is the relief which surrounds the beach. The area near Mandve is rocky and rugged. This region is severely eroded by waves. The sediments are supplied to the beach by the tides. Clayey deposits reach to the beach via River Amba through the Dharamtar creek. The deposits enter the currents and then are carried and deposited on the beach.

The lower beach is covered by a thin sandy layer of 10 to 15 cm thickness in monsoon. This sand is brought from backshore by wave cutting. The beach shows a distinct seasonal metamorphosis. In

monsoon major part of the beach is sandy but for rest of the year it is covered by thick deposition of mud.

The depositional dynamics and environment of Rewas beach were studied initially by this researcher in 1991. The work was based on limited data collected mainly in post monsoon season (Shrikhande 1993). Afterwards the database was extended to monsoon period in next two consecutive years. This helped in giving a clear idea of seasonal changes and the metamorphosis of the beach.

It was found that in monsoon the upper beach exhibits a cut profile and in fair weather, a fill profile. Narrowing and steepening of upper beach, sand cover on lower beach, breakers and tidal waves laden with clays and silts are the salient features of monsoon environment. The beach widens, and slopes gently seawards in fair weather. The sand from the lower beach moves to backshore. The mud on the lower beach is re-exposed. From the end of post monsoon till the beginning of next monsoon, beach is transformed to a mud beach.

The primary mud cracks are 2 to 4 cm wide and 4 to 6 cm deep. The chunks are polygonal in shape. Most of the primary chunks have a surface area of 50 to 500 sq.cm. The cracks are more or less parallel to each other and are connected by secondary network of cracks. The concentration of suspended matter in monsoon waves suggest that the source of mud lies in the near vicinity of beach and monsoon waves act as an agent for propelling mud to the beach.

The mud on Rewas beach is as thick as 30 cm and is covered and protected by the

fine sand in monsoon. The beach is dominated by tides, with a tidal range of 3.5 m.

The beach is oriented Northeast - Southwest, contrary to the North South orientation of other Konkan beaches. This has imparted sheltering and protection from direct south westerly waves. The northeasterly drift, persists for most part of the year and a large amount of finer sediments are deposited in updrift direction near Rewas, Bagdande and Navakhar.

To study the pattern of sedimentation on the beach, sediment samples were collected from 13 different places on the beach. The grain size analysis was carried out by adopting standard procedures. Grain size parameters like mean, sorting index, skewness were determined and used for environmental interpretation (Table 1).

#### A) Mean Sediment Size

Mean sediment size is influenced mainly by energy and duration of depositing medium and composition and durability of sediments. The mean size of sediments from Rewas beach ranges from 0.26 to 3.16 phi indicating that most of the sediments are of fine to medium size.

The increase in sediment size near Mandve (Fig. 5) could be attributed to the removal of fine fractions due to high energy environment of breaking waves. The winnowing action of waves and the movement of the fines through drift has been responsible for accumulation of coarse fraction near Mandve. High energy environment near Mandve is also suggested by occurrence of erosive beach cliffs. Here D<sub>50</sub> of sand is less than 1.5 (Fig. 6).

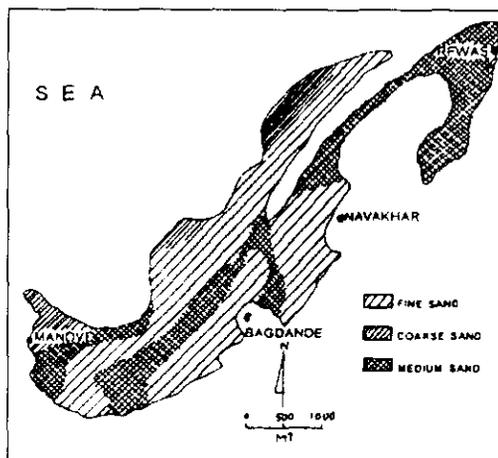


Fig. 5 Mean Sediment Size

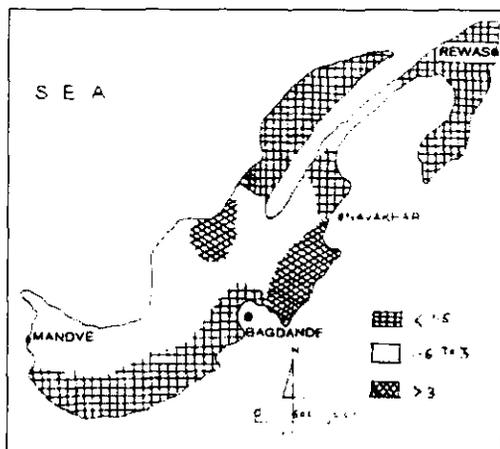


Fig. 6 D<sub>50</sub> of Sediment Size

The influence of coastal configuration and large amount of river discharge containing silty clayey material is implicit in thick mud deposits near Rewas, Bagdande and Navakhar.

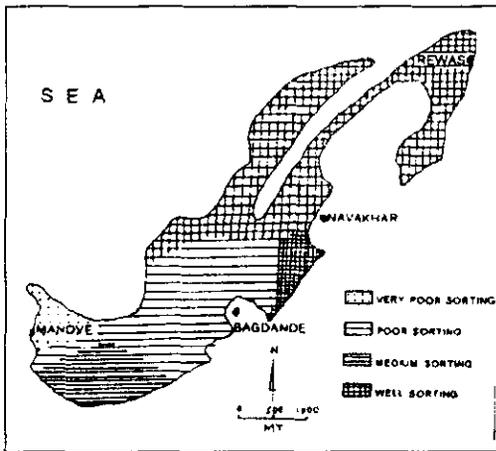


Fig. 7 Sorting Index

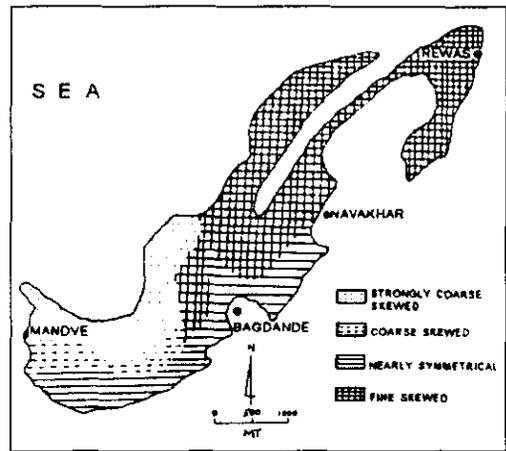


Fig. 8 Skewness of Sediments

### (B) Sorting Index

It is controlled by size, shape and specific gravity of sediments and energy and time involved in transporting medium. The sorting index values range between 0.38 and 2.9 phi (Fig. 7). The fine and silty clay areas on the beach are the areas of well sorted sediments. Poorly sorted sediments are restricted to Mandve area. At places additions of fines have improved the sorting of sediments especially near Bagdande.

### (C) Skewness

It measures the symmetry of the grain size distributions. It is very sensitive to sub population mixing and as such very important in delineating environments. Skewness values range between - 0.47 and 0.93 on Rewas beach (Fig. 8). The sands around Rewas and Navakhar are fine skewed due to concentration of finer particles.

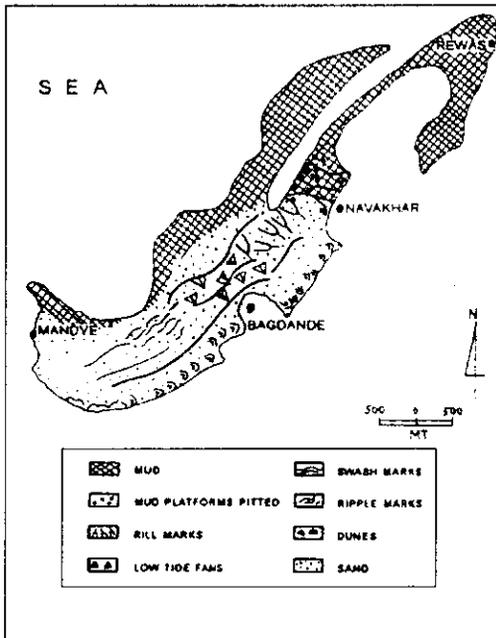
### (D) Clay / Sand Ratio

Dominance of clays on mud beach is clearly brought out by clay/sand proportion in sediment samples (Fig. 9). Except a narrow area along shore to the west, clay / sand ratio is more than 1.5. The clay also appears to be a major component of sediments in the middle section of the mud beach where this ratio varies between 0.5 to 1.5.

### Tidal Microfeatures

In addition to mud which is a dominant bed material on the beach at Rewas there are other rhythmic features such as rill marks, swash marks, ripple marks, and low tide fans, (Fig. 10) developed on muddy surface.

These sedimentary structures temporarily preserved on the beach, provide information about the environment of deposition. Many of these structures are intertidal and microscopic. Their size, shape, thickness and orientation as well as their nature, all help



**Fig. 10** Sedimentary Facies and Tidal Micro Features on Rewas Mud Beach

of nearby shore platforms. The anticlockwise and clockwise movement of tidal currents within the estuary and the inward and outward movement of sediments is responsible for various sites of sedimentation in the outflow area of the creek. The mud beach at Rewas is a result of this creek sedimentation.

In recent years, the mud flats and creek bed are being scoured by the waves. The material has moved to continental shelf and is being brought back to the shore as fine sediments. There are many indications of slight rise in sea level in the area. The scouring and erosion of tidal channels on the mud flats and ancient terraces, the breaching of protection walls, increase in salinity of well waters in nearby villages and the occurrence of mud on the beach are some of the significant indicators of this fluctuation in sea level (Karlekar 1986). This change appears to be localised and is related to increase in sediments on the creek bed.

in understanding the mode of their formation (Allen J. R. L., 1984).

The field observations on Rewas beach revealed considerable variability in these features both perpendicular as well as parallel to the shore. This variability appears to be governed by daily and seasonal fluctuations in tides and waves at Rewas.

### Conclusions

It appears that the sedimentation in Dharamtar creek is responsible for the development of thick and wide mud flats bordering the creek. In addition to the sediments that are supplied by the river, the sediments are also produced by the erosion

The changes in the creek configuration and morphology of beach in the study area are very distinct for last hundred years or so. The historic changes could be inferred from radiocarbon dates of fossil mangrove roots on the mud beach at Rewas. Coastal changes in the area are indicative of rise in sea level causing damage to an extensive section of the littoral.

Presently, the beach is being scoured at an alarming rate, especially in monsoon. The appearance of mud on beach in recent years is an important event in the coastal history of beach at Rewas.

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