CHAPTER - 9

RESUME

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The thesis which deals with the geological and geomorphological aspects of north Maharashtra coastline comprise results of an indepth investigation of the various controlling factors responsible for the evolution of the coastline. Although the west coast of India constitutes one of the most important physiographic unit of the Peninsular India, yet surprisingly not much work has been carried on the coastline by geologists. In recent years some sporadic work has been done on various coastal areas. The Gujarat coastline has been well studied but further south in Maharashtra not much work has been done. The candidate has, for the first time mapped the coastal segment between Dahanu and Kora and his results for the first time, throw considerable light on its geological aspects. The candidate selected this area keeping in mind its location which is just outside the tidal influence of the Gulf of Cambay and also there are no major rivers like those in the north that meet the coast. This coastal

segment facing an open sea has provided an ideal site for the study of the coastal sediment dynamics.

In this thesis the author has presented an integrated picture of the various attributes of the coastline evolution wherein the factors of tectonism, sea-level fluctuations and complex pattern of sediments transport played important roles. Apart from routine studies on the geomorphic aspects, the emphasis has been given are :

(i) The role of regional tectonics, (ii) erosional and deposional landforms related to successive sea levels and (iii) sedimentological and hydrodynamic analyses of the coastal deposits.

The coastline between Dahanu and Kora, falls within the district of Thane of Maharashtra and is marked by North latitudes 19° 30′ and 20° 00" and East longitudes 72° 38′ and 72° 50′. This study pertains to a coastal terrain covering an area of approximately 1575 sq km.

Physiographically, the study area is divisible into three zones viz. (i) Eastern hill ranges and plateau (ii) Coastal plain and (iii) Shore zone. Lying to the east of the alluvial stretch hill ranges rise rather abruptly to form a vast rocky terrain with an average height of about 300 m. Weathering and erosion of these high trappean hills have given rise to a variety of flat topped hill features, buttes, mesas and pedeplain are within the

highlands, at the foot of the hills, subaerial erosion has given rise to extensive colluvial deposits. On going seaward, the rocky terrain passes into the coastal plains. This plain, is characterized by alluvial and residual soils. The coastal plain show a very gentle slope towards the sea and is cut by few shallow streams. The actual shore zone provides interesting coastal features comprising beach, beach-rocks, mudflats, creeks, cliffs and sand dunes.

The drainage patterns observed were dendritic, trellis, rectangular, radial, parallel and deranged. These drainage patterns indicate slope and structural control.

From the stratigraphy point of view, the coastal terrain under study does not provide much diversity, and represents only formations of Cretaceo-Eocene and Quaternary periods. It however, compensates in providing lithologic and geomorphic varieties, which in turn, reveal an interesting sequence of geological events of the Quaternary times.

The Deccan Trap basalts form the oldest rock formation. They are highly jointed and fractured and form north-south hill ranges in the eastern part. They are also exposed as rocky inter-tidal platform at Vadhavan, Tarapur, Muramba, Mahim and Usarni. Field studies show that the Deccan Basalt flows can be divided into two major groups, compact and amygdaloidal, the later showing abundance over the compact variety.

The vast alluvial sediment and coastal deposits of Pleistocene and Holocene epochs, rest directly over a trappean basement.

Quaternary deposits are essentially consists of alluvial, residual deposits, colluvial and shore-zone sediments.

Lineament studies have revealed the following structural features of interest.

i. The most prominent structural features being (i) the Panvel Flexure Axis, (ii) the West Coast Fault and (iii) the Great Escarpment of the Western Ghats.

ii. The overall trend of the various rivers generally follow major fractures.

iii. The most predominent geofracture trends are N-S and E-W, besides minor sets of joints. The N-S and E-W, fracturing and jointing appear to be related to plate tectonics while the other minor sets have been considered as tensional joint related to the shrinkage of the basalts.

Landforms of the study area have been categorised as under :

i - Shoreline landforms : Beach, spit, Rocky platform, Sea-cliffs and coastal dunes

ii - Inland landforms : tidal flats, beachrocks, alluvial plains and residual soils

iii- Trappean landforms

The existing geomorphic set up of the coastal segment under study, typically provides an evolutionary sequence, wherein global geodynamic processes, neotectonism, eustasy and subaerial proceses of erosion and deposition have all contributed their share at apporiate stages of the landform evolution. A critical assessment of the various landforms encountered, points to a sequence of events, initiated with the breaking up of the Gondwanaland at the close of the mesozoic, and culminated in to the present day coastline processes of erosion and deposition. Considering all aspects, including data from the neighbouring areas, the author has worked out the following evolutionary sequence for the study area.

1. Breaking up of the Gondwanaland during the Cretaceous period.
2. Formation of west coast fault.
3. Emplacement of western Deccan Lava flows, followed by dyke rocks.
4. Extensive fracturing and jointing of the traps on account of the N-E movement of the Indian plate.

These events played very important role in formation of the following I and II order landforms as continental shelf, older coastal dunes, recent coastal dunes, beaches, mangroove (swamps) and tidal flats etc..

The studies undertaken to exhibit a variety of landforms suggestive of both submergence and emergence of the coast.

Compositional variations of 60 samples of the foreshore, backshore and dunes areas were studied. The samples have been found to be generally made up of sand grains (terrigenous sand), mud and shell fragments . The sands are generally medium to coarse in size and contains rock and shell fragments. quartz grains, volcanic glass, chalcedony, magnetic minerals and other heavies are common in sand. The rock fragments, are mostly basaltic and are subrounded to rounded. The larger fragments show smooth and more or less polished surface but a few show percussion marks which indicate an energetic environment. Vesicular fragments are filled with secondary quartz, zeolite, calcite, and chalecdony.

Quartz grains are rather fine and subangular to subrounded. Cryptocrystalline silica such as jasper, agate, chert and flint are occasionally observed. Though the average percentage of quartz grains is merely 66.6 %, it shows a maximum concentration of 93 % at Muramba. The maximum concentration of shell fragments is at Tadalpada (41 %) while the minimum concentration of shell fragments (2 %) is seen at Muramba. At Gungwada, concentration of rock fragments reaches maximum 64% then decrease to 8 % at Alewadi.

Statistical parameters of grain size of the coastal sands show diversity in values related to different micro environments of this zone. The three modes of transport, viz. surface creep, saltation and suspension are the chief agencies of sediment dispersal.

The statistical parameters of the coastal sands are sensitive to the various energies. The fine sands or silt of the Dahanu coast is due to the outcropping of trap rocks and the occurrence of mangroove plants that act as barrier shore wave energy is expanded, allowing the suspendates to settle down.

The importance of beach rocks studies lies in locating the early Holocene high strandline. The beach rocks appear to have been deposited when sea level had arisen during the Holocene transgression. A combination of wave action and long shore drift brought about redistribution and redeposition of material along the shelf as well as added by the rivers from landward side or brought from the Gulf of Cambay by tidal currents. The low angle and convex cross stratifications indicate a slow drift of the sediments, suggesting that the sea was not rough during their deposition. Thin parallel lamination also point to a slow reworking process of the sediments by the upthrow swash and back-flow currents in a fairly quiet sea. The variation of gravel percentage is an important indicator of energy variation prevailing at the time of their deposition pointing to the variations in current velocity, wave energy, slope, configuration of shoreline, and amount of sediment supply. The gradual

decrease of clay and increase of silt in different outcrops of the study area on going from north to south may be due to decreasing influence of the tidal currents in the Gulf of Cambay. The variations in the standard deviation values indicate variations in hydrodynamic system and energy which were responsible for the deposition of these sediments. Rounding of particles of beach rocks is mainly by abrasion. The occurrences of these beach rocks at elevations varying from 2 to 8 metres above the present sea level and their local tilting has led the author to invoke the role of neotectonism.

The study of grain orientation of beach rocks and their sedimentary structures reveal that these detrital accumulations are the products of high tidal waves of a high sea level.

The petrographic details of the beachrocks have been obtained on the basis of the routine thin section studies to know the constituents of beachrocks such as allochems, detrital particles and cement.

The author has studied the following six important fabrics in the beachrocks of this area (1.Isopachous fringes, 2. Meniscus cement, 3. Gravitational cement, 4. Micritic cement, 5. Drusy cement and 6. Dog tooth cement).

The origin of cement in these beachrocks appear to fall in following three main categories :-

1. Physicochemical precipitation from evaporating seawater.
2. Physicochemical precipitation by mixing of meteoric water with sea water.
3. Endogenetic cement.

Petrographic studies show different types of diagenesis pointing to (i) marine - phreatic, (ii) marine - vadose (iii) vadose conditions. The three diagenetic types appear to be related to the fluctuations of sea level. Type (i) points to the deposition and cementation by marine water, where as type (ii) and (iii) are indicative of marine diagenesis over which vadose features have been superimposed. Type (ii) represents a partial transformation, while type (iii) points to a complete vadose superimposition.

Surface texures of quartz grains studied under SEM show following diagnostics. V-shaped traiangular pits, and grooves, large etch pits, block, conchoidal breakage pattern, various cracks, etc. These diagonstic features indicate a combination of marine and fluvial processes in the formation of beach rocks.

The diversity in types, size, shapes and occurrences of the sedimentary structures is found to have been controlled by marine proccesses, coast line direction, morphology of the coast and coastal sediments. Three important dynamic proccesses such as wave action, wind and tide affect the beach form.

Important bedforms observed on the Dahanu-Kora coast are ripple marks, swash marks, backwash marks and rill marks. These bedforms are studied in three zones across the different beaches of the study area.

Sediment transport model indicates (i) the S to N transport is dominant over N to S. (ii) the S - N transport is controlled mainly by SW and W winds whereas the N-S transport is related to the ebb tide effect of Gulf of Cambay. (iii) the main bulk of the quartz comes from deeper parts of the shelf, the origin of quartz grain attributed to the Indus river or Narmada, Mahi, Sabarmati etc. river sediments, perhaps dumped when the sea level was - 120 m. during the last glacial period.

The coastline evolution postdates the Flandrian transgression, and its present day configuration and coastal deposits are the accumulative effect of marine processes aided by various factors such as structural, sedimentological and eustatic. Besides the West Coast Fault Zone that has imparted a straightness to the coastline, the degree and extent of outcropping of trap rock, rate of their erosion and denudation, slope of the continental shelf, wave and tidal action and climatic variations have amply modified the coastline morphology. The glacio eustasy during the Quaternary period is manifested in four different strandlines, that have left quite a few imprints each relating to their positions.

The stages and events of coastline evolution have chronologically been summarised below :

1. At the close of the Pliocene or early Pleistocene the coastline must have been straight, rocky or cliffy.
2. During the early part of Pleistocene the first transgression (Tyrrhenian 300,000 years B.P.) submerged the trappean terrains, - the then shorline extending several kilometres inland. Wave action is seen to have carved out a planation surface at an altitude around 20 m.
3. The Wurm regression (30,000 to 20,000 years B.P.) rejuvenated the major rivers that deepened their valley floor and transported large amount of debris several kilometres offshore.
4. The Flandrian transgression (13,000 to 3,000 years B.P.) choked the river mouths that resulted in the dumping of cobble deposits at the coastline. The deposition of beach rocks, coastline ridges, and raised mudflats in the area are the important features of this event.
5. The present day coastline is characteristic of a still-stand stage in the regressional phase where the coastal features are in dynamic equilibrium with the existing position of the sea level.