CHAPTER XI

R E S U M E

XI.1 INTRODUCTION

The present study restricted to the coastline from Jamnagar to Okha Madhi lying between Latitudes 22^{o} N and 22^{o} 30' N and Longitudes $68^{o}57'$ and $70^{o}5'$ E, comprises a systematic investigation of its coastal geology and geomorphology. The investigation included (1) precise geological mapping, (2) study of depositional environments of the coastal sediments,

(3) drainage analysis, (4) comparison of morphometric parameters of the various drainage basins, (5) ground water conditions, (6) salinity affected areas, and (7) terrain classification.

XI.2 GEOLOGY

Geologically, the study area comprises a terrain made up of Deccan Trap lava flows with overlying Tertiary and Quaternary sediments. The lava flows of Deccan Trap make up the dominant rocks, and it is observed that the subsequent deposition of marine rocks was variable in the east and west. While the area to the east of the Okha Rann contains only restricted outcrops of Tertiary rocks, the Okha Mandal block shows a profuse development of these Tertiary rocks. The late Pleistocene and Holocene sediments are less developed, as compared to their thick accumulation over the trap basement and Tertiaries in the southwestern and southern parts of Saurashtra.

XI.3 AIRPHOTO INTERPRETATION

The airphoto studies mainly comprised examination of individual photographs under the mirror stereoscope to decipher different structures like coastal cliffs, stacks, broken grounds, mud-flats, creeks, inland

water bodies, sand ridges, sand dunes, islands etc. along with drainage, lithology and some major morphogenetic units. These features were verified by subsequent ground checking.

Airphotos under mirror stereoscope, typically showed the extension of stream channels inside the Gulf. The streams of 5th and 6th orders have their channel extensions submerged within the Gulf and extending to distances varying between 11 km to 18 km. Stream channels in the limestone region are deep, narrow with steep banks as compared to those on the Deccan Trap. Shifting of channel course in the zones of curvatures could be clearly marked on the airphotos.

The airphotos typically reveal the presence of perennial springs. These springs, near the foot of small hills and hollocks or on the sides of large valleys, were recognised by the presence of dark toned lines of trees and green vegetation starting from the point of emergence of spring to downstream direction for a short distance. The natural lakes, perennial streams, rivers, and springs indicate the closeness of the water table to the surface. The streams on Deccan Trap show a higher Drainage Density, more run off and hence less percolation. In the limestone area, the Drainage Density is low hence they are poorly drained.

XI.4 INLAND GEOMORPHOLOGY

The inland areas which provide a considerable diversity of geomorphic features and controlled essentially by geology and tectonism, have been classified as under :

1) Eastern Mainland,
2) Okha Rann,
3) Okha Mandal Block.

1) Eastern Mainland

Morphologically, the eastern part of the study area is divided into three distinct units :

i) Southern hilly terrain,
ii) Northern and western gently sloping region,
iii) Coastal plain.

2) Okha Rann

An interesting geomorphic feature lying between the Saurashtra mainland and Okha Mandal Block is the trench like flat terrain made up of saline sediments comprising clay, mud and sand. It is a linear NNE-SSW extending depressed terrain with a length of about 21 km.

3) Okha Mandal Block

The far western part of the study area of Okha Mandal has altogether a different geomorphology. It occupies an area of about 600 sq km in quadro-circular shape. The general elevation of the land is about 10-20 m above the sea level. The country rock being limestone, it has given rise to a distinctive topography.

XI.5 COASTAL GEOMORPHOLOGY

The coastal portions of the study area, also show a considerable diversity. Broadly, they can be grouped into two main coastline divisions :

1) Coastline of Okha Mandal (Dwarka coast)
2) Coastline between Jamnagar and Okha Rann (Jamnagar coast).

The two coastlines typically illustrate the diversity brought about by the different combinations of lithology, tectonism and marine processes, operating on a terrain.

1) Dwarka coast

This coastline west of Okha Rann, comprises the semicircular western coastline between Okha and Okha Madhi, the U-shaped portion from Okha to Positra, and the straight NS segment from Positra to Charakla. The entire coastline indicates uplift.

2) Jamnagar coast

This coast, stretching from Okha Rann to Jamnagar is quite distinct from the Dwarka coast. The coastline is muddy having a foreshore width between 500 m to 11 kilometers with mudflat thicknesses increasing gradually towards the sea.

XI.6 DRAINAGE

Lithologically, the area is divisible into two main groups (1) Western-Tertiary limestone (2) Eastern - Cretaceo-Eocene Deccan Trap lava flows. Out of 18 basins, 5 are located on Tertiary limestones and 13 on the traps. All these 18 basins and 6 inter-basin areas occupy 3556.71 sq km. The rivers in the western part i.e. Okha Mandal Block, have no common watershed. In the eastern part, the rivers originate from the central part of the Saurashtra on a ridge parallel to Lat. $22^{\circ}5'$ N. The length and order of main stream channels show a decrease from 53 km to 14 km, the stream order changing from 6th to 3rd respectively from east to west. This fact is adequately reflected in the gradual variation in the various parameters like Stream Frequency, Drainage Density, Weighted Mean Bifureation Ratio, Elongation Ratio, Relief Ratio and Gradient. No major break in profile of any of the river has been observed and they flow on a smooth gently sloping ground.

The drainage analysis has thrown some light on the nature and evolutionary history of the river basins of the study area. Lithology has controlled the Drainage Density and Stream Frequency. Variation in rainfall has also added to the diversity. The most striking and interesting control on the drainage is that of tectonics. The E-W fault that extends along the southern limits of the Gulf of Kutch and the NNE-SSW fault running along the western flank of the Okha Rann, have considerably influenced the drainage behaviour and basin characters.

XI.7 GROUNDWATER

From the point of view of groundwater, the area is not very promising. The lithology is not favourable. The rainfall which is the main source for the recharge of groundwater is also very scanty. Groundwater along the coast is saline and unpotable and people have to depend on surface water collected in the reservoirs. Water wells especially along the western coast are very deep and contain rather significant quantity of water, and majority of them get dry in the summer.

XI.8 BATHYMETRIC STUDIES

It is observed that the navigability of the Gulf coast, is controlled by a number of factors like coastal geomorphology, geohydrographic features, tidal currents and climatic factors. The shoreline is highly irregular and concave in shape and consists of several characteristic features like islands, coral reefs, submerged stream channels and wide mudflats with mangroves. The shoreline being highly irregular and dissected by stream channels, has given rise to a number of islands or bets. Some of these islands are above the water line while others remain submerged even during the low tide.

The southern shoreline of the Gulf of Kutch is full of islands, shoals, coral reefs etc. because of which free navigation is difficult. For this, some creeks were carefully studied and possible deep water lines were marked.

XI.9 TERRAIN CLASSIFICATION

Terrain Evaluation systems aim at (1) the recognition of different kinds of terrain, and (2) knowing the properties of each type of terrain.

Once it has been recognised, the terrain data obtained, classified and stored, could then be utilised for various purposes. One may identify the type of terrain encountered at an unknown site and then apply to it all the information present in the 'pigeon-hole' for that terrain type.

The various terrain attributes, appropriately classified and catalogued, have been described as Pattern and Facets. On account of security requirements, the T.E. Cell Numbers and locations of the indivudual Pattern and Facet have not been given, and instead, the various patterns have been designated alphabetically and the facets have been serially numbered and described. In all, the study area has been classified into 6 Patterns and 40 Facets.

XI.10 TECTONIC FRAMEWORK

The shape of the Saurashtra peninsula, typically reflects its limits being marked by four regional dislocations as under :

1) Gulf of Cambay fault (N-S)
2) Narmada Fault (ENE-WSW)
3) Gulf of Kutch Fault (E-W)
4) West Coast Fault (NW-SE).

Considerable neotectonic activity has been found to be related to these dislocations, and the geological and geomorphological evolution of the Saurashtra coastline during the Quaternary period provides ample evidences of tectonic instability.

One of the most important neotectonic phenomena which has considerable relevance to the geomorphic evolution of the study area, is the conspicuous submergence of the northern Saurashtra coastline.

An important fault that has direct bearing on the coastal evolution is the Gulf of Kutch Fault. The Okha Rann Fault is another conspicuous dislocation, forming the eastern limit of the uplifted Okha-Mandal Block. Because of this fault, the Okha Rann has come into existence and the Tertiaries are repeated on its two sides. In addition to the above two major dislocations, the author has recognised a number of N-S faults, extending for 10 to 15 km at the maximum, and restricted to trap areas. Most of them are strike-slip faults with slip movement of 50 to 70 m. In the Okha Mandal Block, there are clear evidences of ENE-WSW folding. The flat elevated terrain to the southeast of Dwarka, is dotted with sporadic low anticlinal ridges extending

ENE-WSW. These ridges 5 to 6 m high, comprising anticlinally folded limestones of Dwarka, invariably show their northern flanks faulted.

XI.11 CONCLUDING REMARKS

The Saurashtra peninsula as a whole might not be showing spectacular uplifts and subsidences as a single block, but there are numerous indications to suggest that its various parts did undergo differential movements during the Pleistocene and Recent times.

It is most significant to observe that the Saurashtra peninsula as a whole exhibits a distinct northward tilting on an E-W axis, as a result of which while the northern coast of Saurashtra has been gradually submerging, the southern counterpart points to an emergence. This tilting process has been going on throughout the Quaternary period. The various geomorphic attributes of the study area, very distinctly substantiate this tilting phenomenon. The Gulf of Kutch Fault, the Okha Rann Fault and the various smaller N-S and ENE-WSW faults on the trappean mainland and the Okha Mandal Block respectively, would be manifestations of this tilting process, the exact mechanism of which however is not yet fully understood.