CHAPTER - I

INTRODUCTION

PURPOSE AND SCOPE

GEOGRAPHICAL LIMITS

PHYSIOGRAPHY

LAND USE AND COMMUNICATION

APPROACH AND METHODOLOGY

PREVIOUS WORK

PURPOSE AND SCOPE

The West Coast of India, especially that part which falls within the state of Gujarat, is characterised by an unique assemblage of landforms erosional as well as depositional. In its present day morphology, the area ideally reflects the sequence of events dating back since the beginning of the cenozoic era. The Rajpipla hills and the adjoining coastal plains provide an interesting evolutional history wherein the factors of geology, subaerial agencies and coastline marine processes have played an interesting role in varying combinations. The topographic features, drainage characteristics and other relevant geographic factors and attributes of the area studied, reveal a succinct history of the interaction between successive geological events and the natural processes of weathering, fluvial and coastal marine activites. The study has ideally revealed the importance of the lithological and structural controls that have influenced the evolution of the terrain.

The author has, in this thesis made an attempt to analyse the present day characteristics of the terrain in terms of relief, slope, drainage and land use within the frame work of the geological and structural set up. It has now been fully realised that no geomorphic study of a terrain can be complete without appropriate understanding of the geological background. It is with this

conviction that the author proceeded with his study, and in the various chapters of this thesis, he has been able to throw considerable light on the various features of interest to a geographer with the aid of geological evidences. The terrain selected for study affords within a relatively small areal extent, almost all features of interest and its landforms and drainage patterns, throw valuable light on the various events of terrain evolution, the duration of which dates back to at least sixty million years.

The vast outpourings of the Deccan basaltic lava flows, followed by marine transgressions during early Tertiary times, development of Narmada Rift and West Coast Fault and subsequent uplifts and subsidences of the various faulted blocks, all these provide a backdrop against which the present day landscape has to be viewed. The author has made an attempt to correlate the present day geomorphology with the geological and structural framework of the part of Gujarat, and thesis deals with a critical analysis of his observations.

GEOGRAPHICAL LIMITS

The study area comprising the Rajpipla Hills and the neighbouring coastal plains falls within the districts of Bharuch and Vadodara of Gujarat, lies between 21°-25'-45" -22°.15'.16" North latitudes and 72°.34'.19" - 73°.12'.15".

East longitudes. It covers the Sagbara, Dediapada, Nandod, Jhagadia, Ankleshwar, Hansot and Valia talukas of Bharuch District, south of river Narmada, and part of Chhota Udepur (Kawant and Panwad), part of Jambugam, part of Sankheda, part of Dabhoi, Naswadi, and Tilakwada talukas of Vadodara District. In the east, the basalt hills mark the state boundary with Madhya Pradesh and Maharashtra, the western limit is marked by the Gulf of Khambhat. In the north, a small part of the hilly area lies across the river Narmada extending upto the river Heran, while the watershed separating the basins of Narmada, Kim and Tapi marks the southern limit. The area shows an east-west extension of 170 km and is about 80 km wide in the north-south direction, forming an elongated rectangle landscape.

In a broad way, the study area can be said to comprise following physiographic divisions.

1. North eastern rocky to alluvial undulating terrain (north of Narmada).
2. South eastern rugged basaltic hills (south of Naramda).
3. The uplands (south of Narmada).
4. Coastal Plains (south of Narmada).

The trappean hilly region (referred to as the Rajpipla Hills) marks rugged eastern terrain between the river Tapi and Narmada. These hills are obviously the western extension of the Satpura ranges, some hills in the south could even be considered as offshoots of Sahyadri mountains. The hills north of Narmada may be considered in geographical sense, as south-western fringe of the Vindhya hills. The coastal plains that flank the Gulf of Khambhat, form the low lands which merge eastward into the uplands upto 300 m. further east-ward and south-eastward rise upto heights of 882 m (Fig. I-1).

PHYSIOGRAPHY

The study area provides an unique picture of physiographic diversity, confined within the limits of a relatively small area. The most interesting feature is the significant altitude variation from Mean Sea level to as much as 882 m. high trappean hills. At the distance of 35 or 40 km. from the sea, an abrupt change in height is observed, a change that separates the plains from the hills running over the intervening stretch of uplands. This rising trend of the relief is variable from north to south such that towards north, the ridges reach heights upto 650 m. while those in the east and south-east hills rising above the main plateau show heights upto 800 m. Again in the south the hills are as low as 350-400 m. high. In totality, the area thus typically

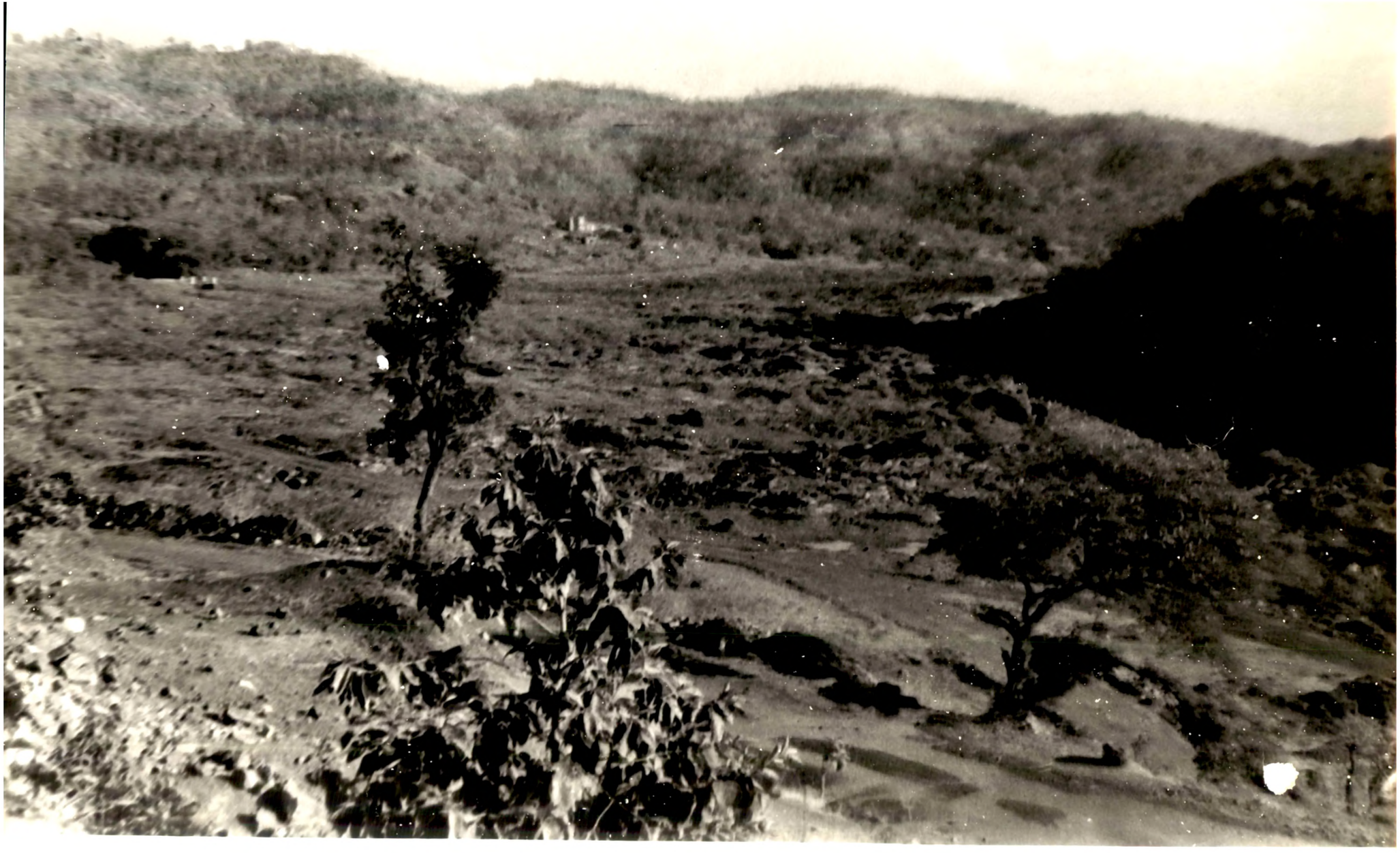

Plate I1 View of the Basaltic bills with intermontane valley.
(Locality : Villages Jitgadh and Zampa).

shows an uneven physiography. Ridges and hills and undulating topography form the rugged hilly terrain in the east, undulating plains in the west and in between these, the dissected uplands made up of low ridges and hills. The eastern and south eastern parts of the area are most elevated with the hill of maximum height 882 m Dhumanmal Dongar near piplod in the Dediapada taluka. General slope of the landscape is towards West and north-west. The east-west aligned ridges form a subparallel sequence with a tendency to show decrease in altitude towards west. The ridges comprise either continuous linear high ground with their summits made up of serrated tops of conical or round hills, or linear stretches of elongated rectangular, square and triangular hills. (Plate I 1).

The drainage system of the study area is mainly related to the Narmada river. The various streams originating in the eastern hills, as also those that drain the area to the north of the river, all meet Narmada. The east-west coursed river Narmada after entering Gujarat in the east at Hanfeshwar and following a straight course for some distance, finally in its lower reaches, starts meandering before it meets the gulf of Khambhat. In this part, tributaries rivers from the north, Ruwel, Men, Aswan (Ashwini) and Heran via river Orsang, meet at Garudeshwar, Tilakwada and Chandod respectively. While

rivers from the south viz. Devganga at Surpan, Karjan at Rundh and rivers Madhuvati, Kaveri and Amravati form their confluences at Jhagadia, Shukaltirth and Ankleshwar. Heran, Ashwan, Men and Ruwel (east-west coursed) rivers have narrow elongated rectangle basins (catchment areas). Rivers Devganga and Karjan (South-north subsequent) have oblong or square shaped basins. But river Amaravati, Kaveri and Madhuvati are again east-west coursed and are seen shifting towards northwest to meet the river Narmada. The basins of these rivers are also elongated rectangular. The river Kim, south of river Amaravati is a consequent. Stream flowing into the sea from the east and this has also an elongated rectangular basin on the coastal plains.

It is obvious that the geological factors like structure, lithology and slope diversity influenced the drainage development and have resulted to varied types of drainage patterns, even within the individual basins and river systems. The various streams have evolved a dissected landscape where a distinct influence of fault and joints is observed. Streams and rivers show elongated courses in directions like west, southwest and north-west. The various tributaries tend to meet in most of the cases at right angles to the main stream. Moreover, the zigzag nature of the streams within the rocky areas are essentially controlled by joints, while those flowing over the softer

areas of coastal plains owe their meandering to a lack of gradient. Radial, parallel and rectangular drainage are normal on the ridges, hills and on the high elevated plateaux and uplands. Foot-hills, valleys, uplands and plains have parallel rectangle drainage modified to trellis patterns. And towards west in the river valleys, flood plains and coastal plains rectangular pattern is observed modified to trellis and dendritic pattern.

The responses of the various rivers aided by the normal subareal processes of weathering to the geological diversity of the study area are ideally manifested in the well defined landforms both erosional and depositional and the landscapes of the areas to the north and south of the Narmada river are quite distinct from each other. In a general way, the terrain to the north provides a subdued topography with sporadic east-west ridges and hills separated by vast plains. On the other hand, the terrain to the south of Narmada river, provides a larger diversity, the trappean highlands in the east are rugged, characterised by linear ridges and elongated plateaux. The uplands and the coastal plains on the other hand are quite different in physiography. The former are characterised by undulating ground across which flow westerly meandering streams. The ground comprises soft sediments of either Tertiary or Quaternary ages. The uplands

gradually merge into featureless coastal plains where the erosional aspects are restricted to entrenched meandering channels. The depositional features are more pronounced, well represented in the bigger river channels and coastal areas. Broad valleys of river Heran, Narmada and Karjan along their courses show depositional features like sand bars, islands, and braided river channels. Near the coast, flood plains and mudflats along with the estuaries and coastal creeks, characterise depositional landforms.

The diversity in landscape is considerably a reflection of geology of the area. The oldest formations are the sedimentary rocks of Bagh beds (Cretaceous) which occur as inliers within the basalts of the Deccan Trap (Cretaceous - Eocene). The Tertiary rocks - Sandstones and limestones rest over the Deccan Trap, while the Pleistocene alluvium either comes directly over the trap or is resting over the Tertiaries. These geological formations are controlled by east-west folding and faulting and the combination of lithology and structure has played significant role in sculpturing the landscape.

LAND USE AND COMMUNICATION

In general land of the region comprises following four units on the basis of their use :

Land under forests	20.25%	1,23,317.28 hectares.
Cultivable land	58.20%	3,54,309.22 "
Culturable Wasteland	6.75%	41,084.20 "
Land for settlements and other use	14.80%	90,069.63 "

Forests of the area are confined to ridges and hills of Jhagadia, Valia, Nandod, Dediapada, Sagbara, Kawant, Naswadi and Tilakwada, Nandod, Dediapada and Sagbara, i.e. south eastern hills consist of one third forest land. These forests are tropical dry deciduous of two sub-types (1) Dry teak forests, and (2) Dry mixed deciduous forest. But these two are so merged with each other that forests are called as dry deciduous forests. Yet locally forests of the area can be separated into two :

i. Forests north of river Narmada, and
ii. Forests south of river Narmada.

i. Forests north of the river Narmada : The forests of Kawant, Naswadi and Tilakwada are dry mixed deciduous, on dry and shallow soil on undulating well drained hills. The upper slopes of high hills are thinly covered, or grassy and large parts have out crop rocks. Teak grows best on the lower slopes of hills and in valleys.

ii. Forests south of river Narmada : These can be classed in two : a) Tropical moist deciduous forests in the part of Dediapada east range, in the part of Gorwa,Juna Raj and Rajpipla Ranges. The terrain is mostly hilly with gentle slopes. Hill tops of the average height 15-30 m are covered by forest vegetation and bamboo plantation.

(b) Mixed dry deciduous forests with teak. The remaining areas like sagbara, Dediapada West, Valia and Netrang had once luxuriant growth of vegetation but now vegetation has decreased considerably. In this group, there is no distinction between overwood and underwood forests. Dense vegetation is on the hill tops and slopes. The average top height varies from 3 m to 15 m. Bamboo is sparse and of poor quality.

Low relief, undulating yet relatively flat dissected terrain with different types of soils provides fairly good cultivable land. Gentle hill slopes, foothills, uplands, plateaux, flood plains and coastal plains consist of cultivable land along with forests, waste and cultural land use. The study region consists 58.20 % (3,54,309.22 hectares) of cultivable land which is unevenly distributed among the talukas of the area. The western coastal plains of Jhagadia, Ankleshwar, Valia and Netrang have maximum cultivable land 71.07% (1,50,017.81 hectares). While southern hilly region of Dediapada, Sagbara and Nandod consists 44.60% (i.e. 1,13,202.35 hectares), minimum in the region.

The crops grown in the area, are paddy, groundnut, bajri, tobacco, maize, rabi, jowar, wheat, and tur while with the help of irrigation, cotton, paddy and jowar crops are also grown. In the rocky or hilly soils the

crops taken are maize, groundnut, cotton, paddy, jowar, wheat and pulses. In loamy alluvium soil the crops cultivated are bajri, jowar, wheat, cotton and groundnut and other staple food crops like kodra, jowar, banto, banti, long and vegetables.

The wasteland that constitutes about 6% (41,084.20 hectares) of the area is mainly confined to the dissected valley or hilly terrain called as Kottar, Kharbo, Khadi, nala etc., some of this land is used for cattle grazing. The coastal areas also form a sort of waste land, th is land includes raised mud flats and saline creeks along the coast. The land other than above known, as cultural land available for village settlements, is about 14.80% (90.069.63 hectares), and among the three (northern, eastern and western) divisions the northern hills have maximum land under this category (17.44% - 25,072,44 hectares) but village settlements are sparse in the south eastern hills.

The Rajpipla hills and the neighbouring coastal plains are well linked with the other parts of Gujarat and India by rail and road. Bombay-Delhi broad gauge railway line runs across the area, Ankleshwar and Bharuch being the two important railway stations. Narrow gauge railways fron Ankleshwar to Rajpipla almost follow the

river Narmada and to Netrang extending almost eastward via Jhagadia. In addition to the rail communication, the area has well developed network of roads. The National Highway No.8 runs parallel to the broad gauge railway, and to this highway meet numerous state highways and district roads; thus in totality almost all parts of the study area are well connected with roads, except the south eastern hilly terrain.

APPROACH AND METHODOLOGY

As already spelt out in the beginning the author has aimed at emphasizing the geological base of the geomorphic evolution of the total landscape of the study area. Obviously, to achieve the objective, he had to work out an appropriate methodology wherein all available details of stratigraphy, lithology, structure and allied geologic phenomena of the study area was correlated with the existing terrain characteristics.

The various steps taken by him to obtain relevant details, therefore comprised as under :

1. Perusal of all available geological literature, on the basis of which a clear picture of the geology of the study area could be obtained.

2. Selected traverses taken in the study area to acquaint with the different rock types, their

mode of occurrance and response to weathering processes.

3. Analysis of toposheets and satellite imagery (i) to work out the physical features related to geological formations, (ii) to study the fracture pattern, and (iii) to understand the marine processes vis-a-vis shoreline features.

4. The regional terrain evolution is viewed entirely on drainage and slope analysis and this work has been carried out on the topographic maps scaled as 1 : 2,50,000 (toposheet No. 46 C, F, G, J and K). Further, the Raize and Henry and Smith's (1935 & 1937) method of analysing'relative relief' is used. Even cross-section profiles, hypographic curve showing altitude and area, altimetric analysis by histrograph and frequency curves are also used to analyse the relief. And for slope characteristics cross-section profiles are drawn and used from small scale maps (1 : 50,000).

5. Morphometric analysis of drainage and comparative analytic study of drainage system and pattern from the topographic maps (1 : 50,000) is also the prime aspect in the study of landscape. For this the improved method of Strahler (1952), is used. The data from the morphometric analysis of selected

parameters are compared. The selected dimensionless parameters (Properties) are stream order number, stream length ratio, bifurcation ratio, relief ratio, density, frequency and basin area etc. River longitudinal profiles and cross section profiles are used to describe the rivers, their basins and landforms.

6. Another important feature in respect to methodology for the evolutionary study of terrain is the lineament analysis. For this the ridges and rivers lineament map is prepared (from 1 : 2,50,000 scale toposheets) and star diagrams are drawn showing the trends and patterns of streams and ridges, normally east-west aligned and elongated parallel pattern.

PREVIOUS WORK

The present author was considerably handicapped on account of almost total absent of previous studies on the problem taken up by him. Though considerable geological investigations have been conducted in the various terrains of Gujarat State, no one has ever attempted at geomorphic studies. The present author had to therefore scan through a variety of literature pertaining directly or indirectly to one or the other aspect of the study area, and take out all relevant data.

Looking to the scope of the study, the author has attempted to fully utilise all available references, reinterpreting the information collected to arrive at his own conclusion. The authors whose works have been referred by him include Foote (1898), Bose (1908), Smith (1935), Horton (1945), Strahler (1957), Wadia (1957), Palande (1961), Subramanium & Parimoo (1963), Leopold et al (1964), Fairbridge (1968), Krishnan (1968), Chandra & Chaudhary (1969), Dikshit (1970), Mehta & Patel (1971), Shenoi & Basu (1971), Bedi (1972), Rajyagor (1979), Powar (1981), Biswas (1982) and Mern (1982).

For the study of drainage, relief and slope analysis and environmental aspects some books and reports are also used : Davis (1954), Thornbury (1954 & 1969), Chorley (1969), Doornkamp & King (1971), Monkhonse (1971), Chansarkar (1974), Schumm (1977), Singh (1979), and Rai (1980).