

CHAPTER 1
INTRODUCTION

1. INTRODUCTION

1.1 BACKGROUND INFORMATION ON GUJARAT

The state of Gujarat comprises an area of approximately 2,00,000 sq km and is enclosed within the North Latitudes 20°10' to 24°50' and East Longitudes 68°40' 74°40'. It furnishes an interesting example of a terrain endowed with geologic, physiographic and climatic diversities. Geologically, Gujarat provides a wide spectrum of rock types of different ages. Whereas the Aravalli in the NE is as old as 2,500 m.y., the unconsolidated alluvial and beach material in its central and western parts date back to a few thousand years only. All the important lithological types, igneous, sedimentary and metamorphic, occur within the State.

The geomorphic diversity is a reflection of various combinations of geologic and climatic factors. The structural disposition of varying rock types governs the geological conditions whereas the climatic factors (rainfall, temperature and wind) which vary greatly are reflected in the surface features. The long coastline, the extensive alluvial plains, the vast saline wastelands, the rocky tablelands and the hill ranges, all have their own distinct, geologic and geomorphic characteristics. Physiographically, the state of Gujarat consists of following three distinct zones, a) Mainland Gujarat, b) Saurashtra and c) Kachchh. Each of these is marked by their own characteristic coastline. The *Mainland Gujarat* is further divisible into two well-defined sub-zones: (i) the Eastern Rocky Highlands and (ii) the Western Alluvial Plains. The *Eastern Rocky Highlands* which show an altitude range of 300 to 1100 m are the extensions of the major mountains of West India-the Sahyadri, Satpura and the Aravalli. The *Western Alluvial Plains* comprise a thick pile of unconsolidated sediments deposited by a combination of fluvial and aeolian agencies mainly during the Quaternary period. *Saurashtra peninsula* forms a rocky tableland fringed by coastal plains, a

major portion of which is occupied by the Deccan lava flows. The central part is made up of an undulating plain broken by hills and considerably dissected by various rivers that flow out in all directions. The eastern fringe of Saurashtra (that separates it from the Mainland) is a low-lying ground marking the site of the former sea connection between the Gulfs of Kachchh and Khambhat. Today, it is seen as a saline wasteland interspersed with marshes and lakes. To the north, the Saurashtra peninsula is flanked by the Gulf of Kachchh and to its west and south, lies the Arabian Sea.

1.2 PURPOSE AND SCOPE

Kachchh region, generally referred to as Kutch or Cutch, forms an important pericratonic Mesozoic-Tertiary sedimentary basin along the western continental margin of India. The region is bordered by different tectonic elements, viz. Nagar Parkar ridge in the north, Radhanpur Badmer Arch in the east and Kathiawar block in the south (Biswas, 1982, 1987). Geological set-up of the region offers a variety of problems related to stratigraphy, palaeontology and structure. For more than a century, it has attracted attention of geologists from the country as well as from abroad (e.g. Wynne, 1872; Oldham, 1898, 1926). It is famous for its Mesozoic and Tertiary stratigraphic and palaeontological records/columns, and has been an ever-hunting ground for stratigraphers, sedimentologists and palaeontologists. However, it needs to be highlighted that Kachchh provides a unique example of a tectonically controlled landscape, an aspect that has remained practically uninvestigated. It has been established that since the advent of Jurassic, Kachchh has been continuously witnessing tectonic turmoil right upto the Quaternary (Biswas, 1974, 1987). However, except for the documentation of major E-W faults and a few conspicuous domal structures (Hardas, 1969, Biswas, 1987), little has been said on the deformational history of the area. The continuing tectonic instability during the last few thousand years is ideally

reflected in the periodic visits of earthquakes, giving rise to various geological imprints. Overall geomorphology of Kachchh, including the two Ranns as well as the rocky Mainland, typically points to an interesting sequence of tectonic events. Kachchh region in general and the Mainland in particular offer a unique opportunity to study structural, seismic and tectonogeomorphic aspects. The Kachchh Mainland Landscape is dominantly a product of successive tectonic events; recorded today by the two longitudinal faults namely Kachchh Mainland Fault and Katrol Hill Fault. These represent the sites of important structural changes spread over almost entire Cenozoic era. Biswas (1987) envisaged that these faults initially comprised tensional rifts that developed during northward drift of the Indian sub-continent to subsequently change over to reverse faults when the rifts tended to close. The doming, fracturing and flexuring of the strata are the manifestation of compressional stress regime related to closing of the faults and their changing over to reverse faults, mainly during the closing period of Tertiary and the whole of Quaternary period. Kachchh region as a whole still continues to be a zone of active tectonism and obviously the frequent earthquakes that visit this area are the manifestation of the continuing movements. Its topography is marked by well-defined escarpments, a clear reflection of the active influence of tectonics. Various events have given rise to a wide assemblage of landforms and fracture related stream network. A careful scrutiny and appraisal of the landscape including those of the stream courses has led to some very interesting observations revealing the significance of the uplift of Katrol Hill. It is, however, a relatively less striking structural lineament as compared to the other two i.e., Kachchh Mainland Fault and Island Belt Fault. Thus Katrol Hill Fault (KHF) forms as one of the most important tectonic features of the tectonogeomorphic evolution of the Mainland. In fact, the present day topography and drainage of the area are very clearly controlled by the uplifts related to Katrol fault.

The present study is an attempt to describe the structural and tectonic features of the Katrol Hill Zone (KHZ) vis-à-vis Kachchh Mainland and relate these with recent tectonic events and seismicity of the region. The study as a whole has enhanced existing database and perceptions regarding the structure and tectonics and has in turn helped towards understanding possible seismic hazard encountered in the area.

1.3 GEOGRAPHY OF THE AREA

Kachchh Mainland forms a region intermediate between the plains to the north and Gulf of Kachchh in the south. The present study is carried out on an area of about 1800 sq km termed here as Central Kachchh Mainland alongwith some additional investigations in Banni Plains and Great Rann to corroborate author's views/findings (Fig 1.1).

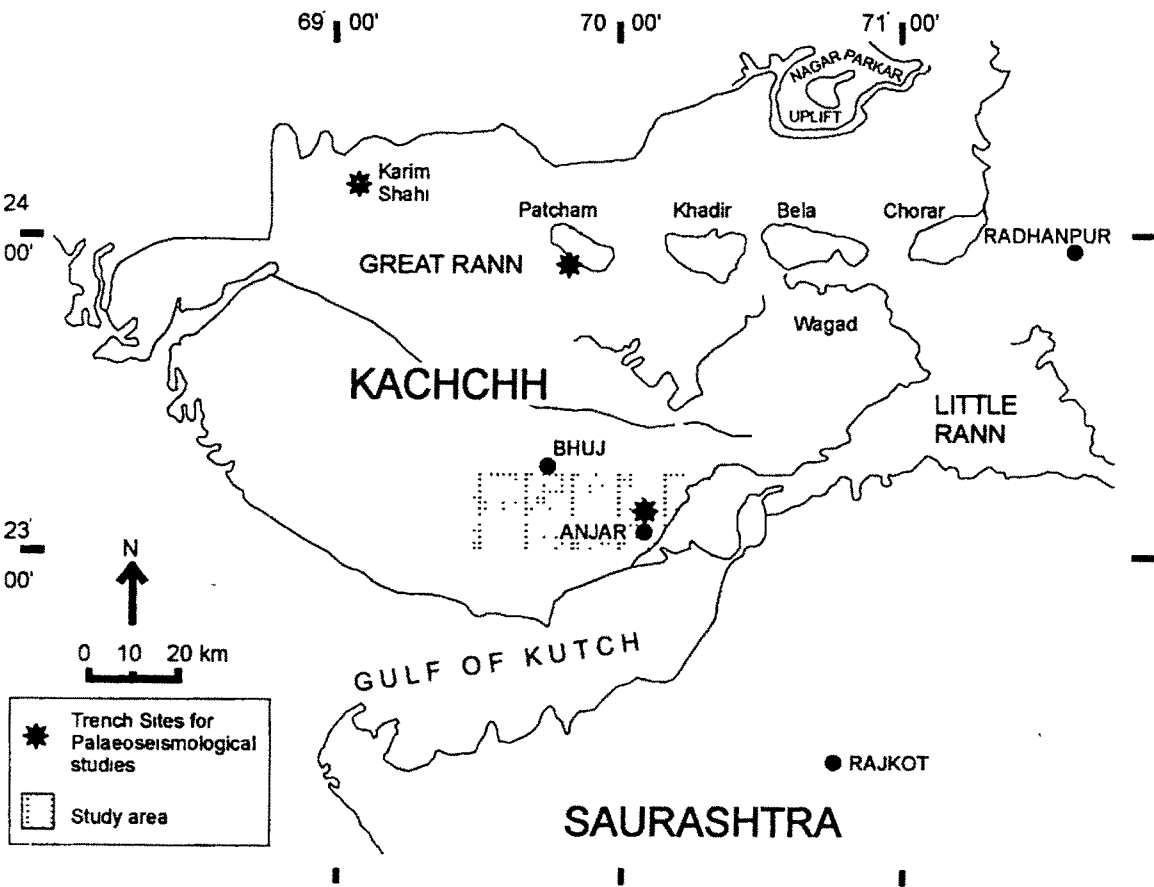


Fig 1.1 Location Map of the study area. Star sign in the figure shows the sites at which the palaeoseismological investigations were carried out.

The area broadly falls between 69°30'-70°15' East Longitudes and 23°00'-23°15' North Latitudes. It gets covered within the Survey of India 1:25,000 topographic sheets 41I and 41E and is well covered in 1:50,000 topographic sheets 41E/12, 41E/15, 41E/16 and 41I/4. The geographic limits start a few km from Desalpur in the west right upto Anjar and further east. Important towns located in Central Kachchh Mainland are Bharasar, Mankuwa, Bhuj, Dahisara, Madhapar, Bharapar, Kera, Kukma, Ratnal and Anjar from west to east. Although most of the work is restricted within above-mentioned geographical limits, for analogical purposes and studies related to palaeoseismicity the area to its neighbourhood is also considered, especially the region that includes Kachchh Mainland Fault, Banni and the Great Rann (Fig. 1.1).

1.3.1 Topography

Kachchh as a whole demonstrates varied topography from high hills to low grounds and coastal plains. In general, it can be broadly divided into three main geomorphic zones i) the hilly terrain; ii) low lying plains and iii) coastal zone iv) salty marsh or Ranns (Fig. 1.2).

The area taken up for study has a rugged topography and is characterised by high Katrol Hill Range, the Bhuj lowland to its north; the Bharapar plains to its south and high sandstone and trappean hills further south. The northern and extreme southern part forms a highland country in the area. The northern hills comprise east-west extending Katrol Hill Range (KHR) comprising Mesozoic sediments. The highest elevations seen in these hills are, Bharasar anticline (254m), Tapka Devi (~234m), Marutonk hills (221m), and Khatrod (349m) and Aduwa Hill (271m). This being the highest hill range, it marks the main drainage divide of the area and for that matter the whole of Kachchh Mainland. The southern hills comprise Mesozoic sandstone and Trappean ridges. The notable elevations in these hills are

Sanosra dungar (240m), Dhola dungar (~300m), Satkhuna dungar (286m) and Chakar Hills (225m).

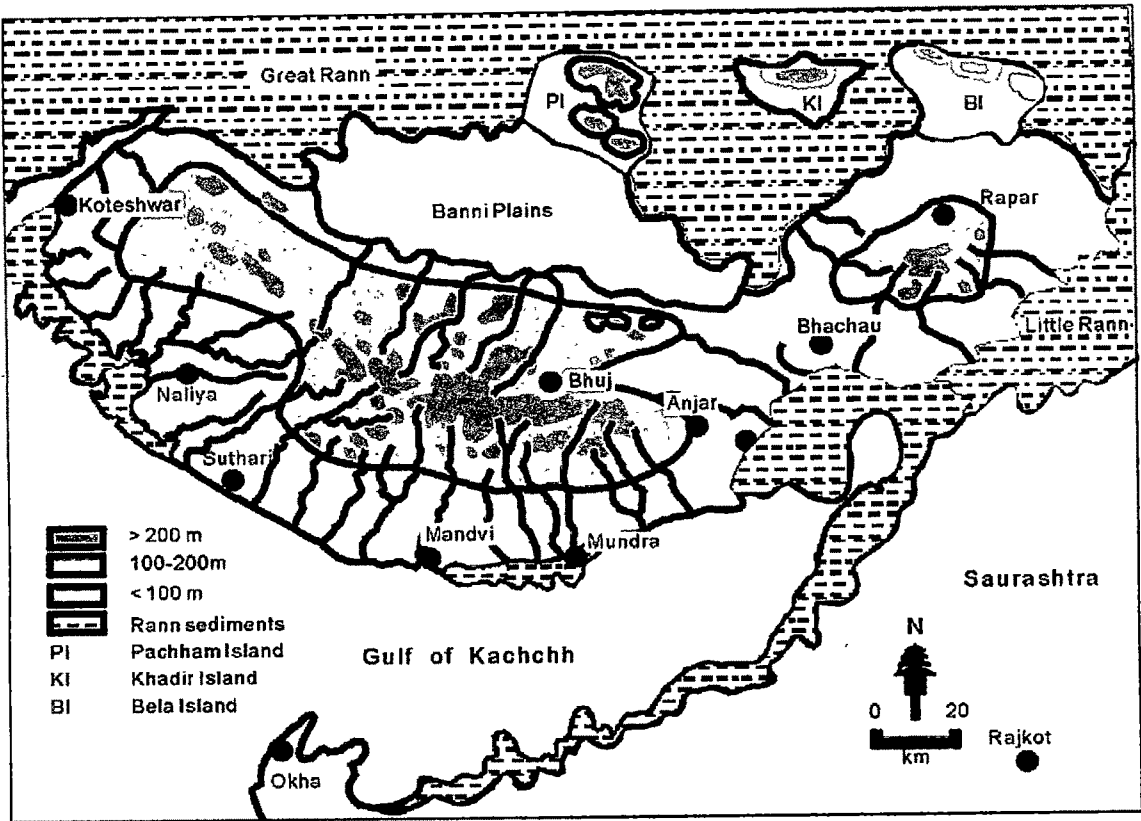


Fig 1.2 Figure showing the general topography of Kachchh region

The low grounds lie to the north of the KHR and are also present between the KHR and southern hilly tract. Relatively flat ground starts after Anjar at the eastern termination of KHR and further east (Fig 1.2).

1.3.2 Drainage

Most rivers and streams originate from the central part of the area comprising the major drainage divide (KHR). The streams drain the slope to north and south of KHR. Although, KHR is the main drainage divide for the north and south flowing streams some small dimension streams do originate from the comparatively less higher hills to the south (Sanosra dungar hill range). The drainage pattern in most cases is dendritic, however, radial

drainage do exist at places marking the presence of domal structures. As climate of the region is arid to semi-arid almost all streams and rivers are dry during most part of the year and in turn there is less sediment supply to the Gulf and the Rann. The major south flowing rivers of the region are Kankavati, Naira, Vengdi, Khari, Rukmavati, Bhukhi, Nagavanti, Phot, Sarkari, Lerakh and Song. The major north flowing streams are Nirona, Kaila, Khari, Pat and Kaswali; and Kaila, Khari, Pat, Sang and Kaswali are studied in detail. Often, the rivers in the region get good amount of water during rainy season and occasional flash floods are seen during the periods of good monsoons. At many places both surface and subsurface waters are mostly saline to brackish; however, the Bhuj sandstone has been the reliable source of subsurface potable water throughout Kachchh and the area under study. Within the study limits some lakes and ponds are also present wherever there is some depression or synclinal portion.

1.2.3 Climate

The rainfall in Kachchh region is highly erratic, with an average of 350mm per annum. The variation in annual rainfall is very high. According to available data in last 50 years the annual rainfall in the district was less than 80% of normal in 17 years, of which for 8 years it rained less than 50 %.

During the present century the highest rainfall occurred in 1926, it rained almost 266% of the normal and the least rainfall is marked in 1938 when only 19% of normal rainfall occurred (Kachchh District Gazetteer, 1971). It can be clearly seen from Fig 1.3 that the mean annual rainfall varies between 300-400 mm. However, it is seen that most of the years in the recent years the rainfall is either normal or is less than that.

The days during May and June are very warm with temperature reaching 46°-48°. The nights are usually pleasant due to westerly cool breeze. In cold season i.e. winters the

interior parts of the district are more cold and may be 4°-5°, much colder than the coastal tract. Occasionally, the minimum temperature goes upto 1° in peak winters (Kachchh District Gazetteer, 1971).

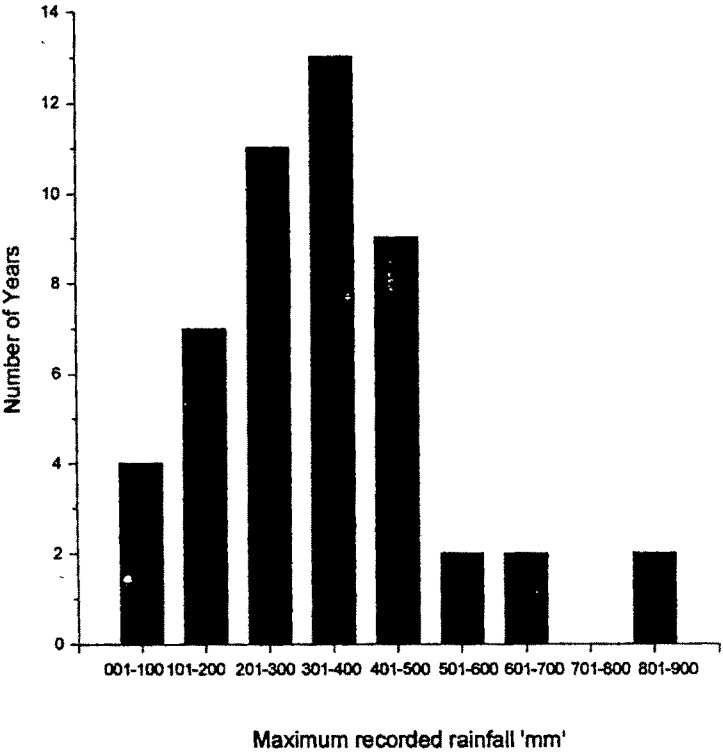


Fig 1.3 Rainfall data of last 50 years for the Kachchh region (data taken from Kachchh District Gazetteer, 1971)

The winters are followed by summer season which, extends from April right upto June. The rainy season with southwest monsoon extends from June to middle September. The violent dust storms and whirlwinds are quite common. Comparatively, post-monsoonal season experiences weaker winds. A progressive decrease in rainfall is observed to north.

As is seen the climatic conditions in the region are not of the nature that can play a lead role in shaping the landscape. Hence, the author is of the view that the general

geomorphology of the region is less affected by the climatic conditions in the region and therefore tectonic factors must have pronounced effect on landscape in general.

1.3.4 Vegetation

On account of semi-desertic to desertic conditions, most of the area in Kachchh region is more or less barren. The only flourishing plants are that of Babul (*Acacia Senegal*) and Cactus (*Euphorbia*). However, owing to good ground conditions in some areas, restricted cultivation is done. The western part of the region is more barren than its eastern part. Realising the importance of vegetation in this barren region the administrators have kept aside some specific areas known as rakhals to stop tree felling and grazing. This has proved to be a good step towards creating a block of regular forests. The total forest area of the region is about 1000 sq km out of which about 110 sq km are the reserved forests, 210 sq km are considered as protected forests and 700 sq km of unclassed forests. The vegetation in the region can be classified in three general categories. a) *The southern coastal tract*, this zone consists of swamps vegetated by mangroves. Also, on the sandy flats the dunes are vegetated by grass. The predominant species which mark the area are Tavar (*Avicennia Officinalis*), Khip (*Leptadenia Spartium*), Dariya Kansdo (*Casuarine Equisetifolia*) and Limdo (*Melia Azadirachta*). b) *The Central Hilly Tract*, this region hilly terrain predominated by Mesozoic sediments. It has an alternate hilly tract and Fertile flats within. The most of the study area falls within this zone. The important species are, Baval (*Leucoene Glauca*), Shami (*Prosopis Spicigera*), Khakro (*Butea Frondosa*), Khari Jal (*Salvadora Persica*), Gangeti (*Grevia Populifolia*), Bordi (*Zizypus Jojuba*) and Thor (*Euphorbia Tirucallis*) and c) *The Northern Tract including the Great Rann Of Kachchh*, this zone consists of vast sandy loam tracts. The area is sparsely vegetated, however, in recent times it is profusely under the influence of Gando Baval (*Prosopis Juliflora*). This plant has

remarkable growth rates and can survive in any condition. This variety is found in Kachchh and north Gujarat. The other important plant species found are, Jacha Baval (*Acacia Arabica*), Kerdo (*Caparris Aphylla*), Khari Jal (*Salvadora Persica*), Shami (*Prosopis Spicigera*) and Pras (*Tamarix gallica*).

Apart from the above-mentioned varieties commercial fruit bearing trees like Mango, Chikoo, Dates, Coconut and Guava are important. The district is famous for Coconuts and Dates.

1.3.5 Fauna

The Kachchh district as a whole is famous for its wild life and bird sanctuaries. The wild life mainly includes deer, fox, wolf, hyena, jackal and blue bull. The region is known for endangered species, the wild ass. The spiny tailed lizards called Uroamstix and different varieties of snakes are common. The northern part i.e. the Great Rann of Kachchh and Banni tract has one of the most poisonous snakes known as Pandi (Gazetteer 1971); the other species include cobras and vipers. The history of the region says that it had a large population of Leopards but now are much scanty almost vanished.

Flamingos, pelicans and great Indian bustards are the noted birds of the Great Rann of Kachchh. This place is known as their nesting ground. In addition to these a Variety of birds such as crane, stork and duck can be seen around the water ponds.

1.3.6 Population

In general, Kachchh is somewhat a backward and underdeveloped region. When compared to Mainland Gujarat and Saurashtra. The region is sparsely populated and the local residents of follow mainly Hindu and Muslim faiths. According to Census of 1961 the population of Kachchh region is 0.6 million.

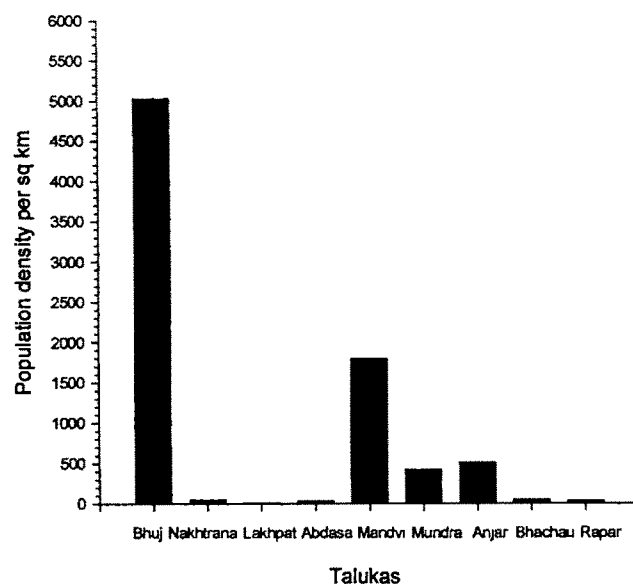


Fig 1.4 Figure showing the population density of different towns of Kachchh district (source: Kachchh Gazetteer, 1971)

Bhuj, Anjar, Mandvi, Mundra, Abdasa, Bhachau and Rapar are the most densely populated areas. It can be seen from Fig 1.4 that the average population of different towns in the region is low.

1.3.7 Communication and Transport

Kachchh district is well connected by air and road to different parts of Gujarat (Fig. 1.5). It is connected by a meter gauge line of Western Railways to Palanpur junction which, is on the Ahmedabad-Delhi line. Also, Gandhidham one of the principal business centres of Kachchh a broad gauge line connects it with Ahmedabad and further upto Bombay. Bhuj and Kandla are the principle towns of Kachchh and have air connections to Bombay, Rajkot, Jamnagar and Ahmedabad.

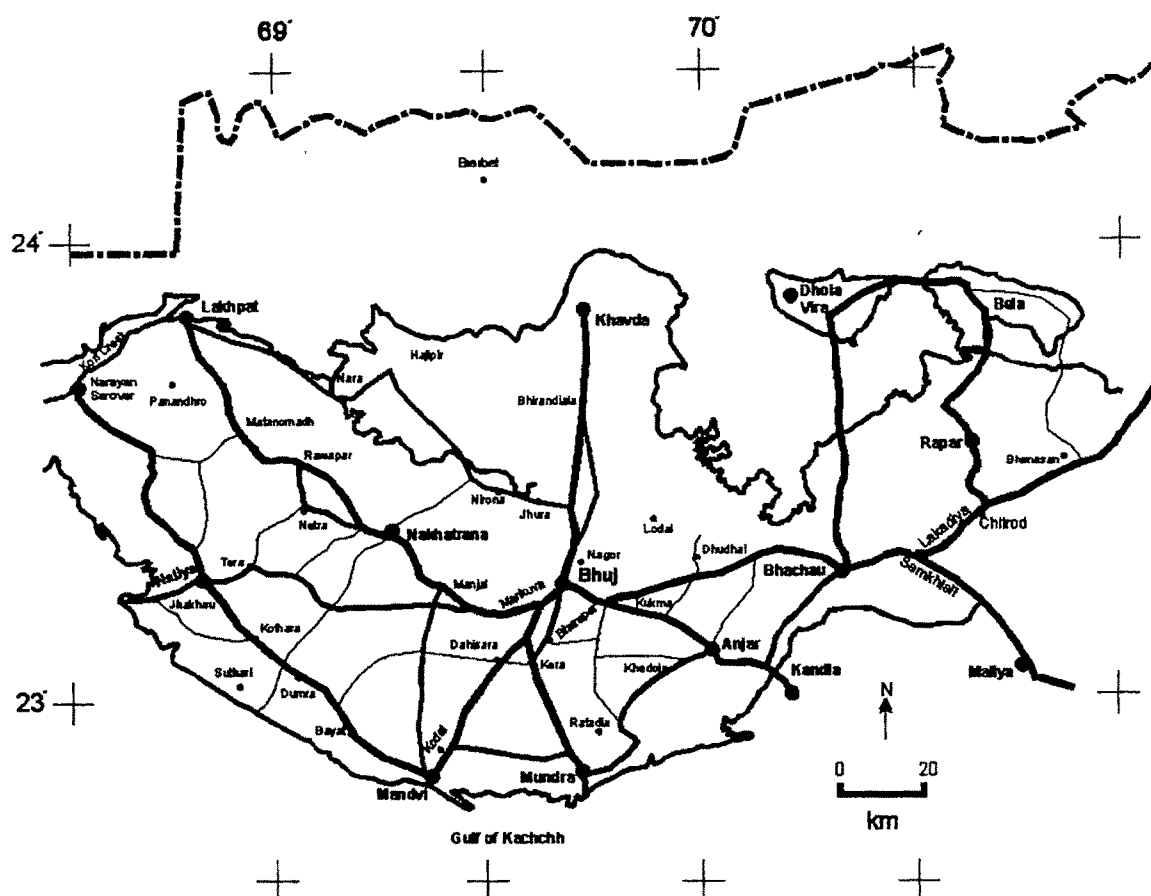


Fig 1.5 Communication Map of Kachchh region

There is a ferry service between Kandla and Navlakhi throughout the year. The motorable road link with Saurashtra exists through the Little Rann. Almost every part of Kachchh district is approachable by jeep and bus. Although, all the major towns and villages are connected by all weather roads some parts become unapproachable due to lack of good roads, especially during the rainy season. State transport buses and private vehicles ply almost every part of the district. Postal communication is quite well organised all over Kachchh. Each big village has a sub-post office, telegraphic office and STD-PCO.

1.4 GEOLOGY OF THE STUDY AREA

The area constitutes the rocks of almost all the age groups that are exposed in Kachchh basin (Fig 1.6).

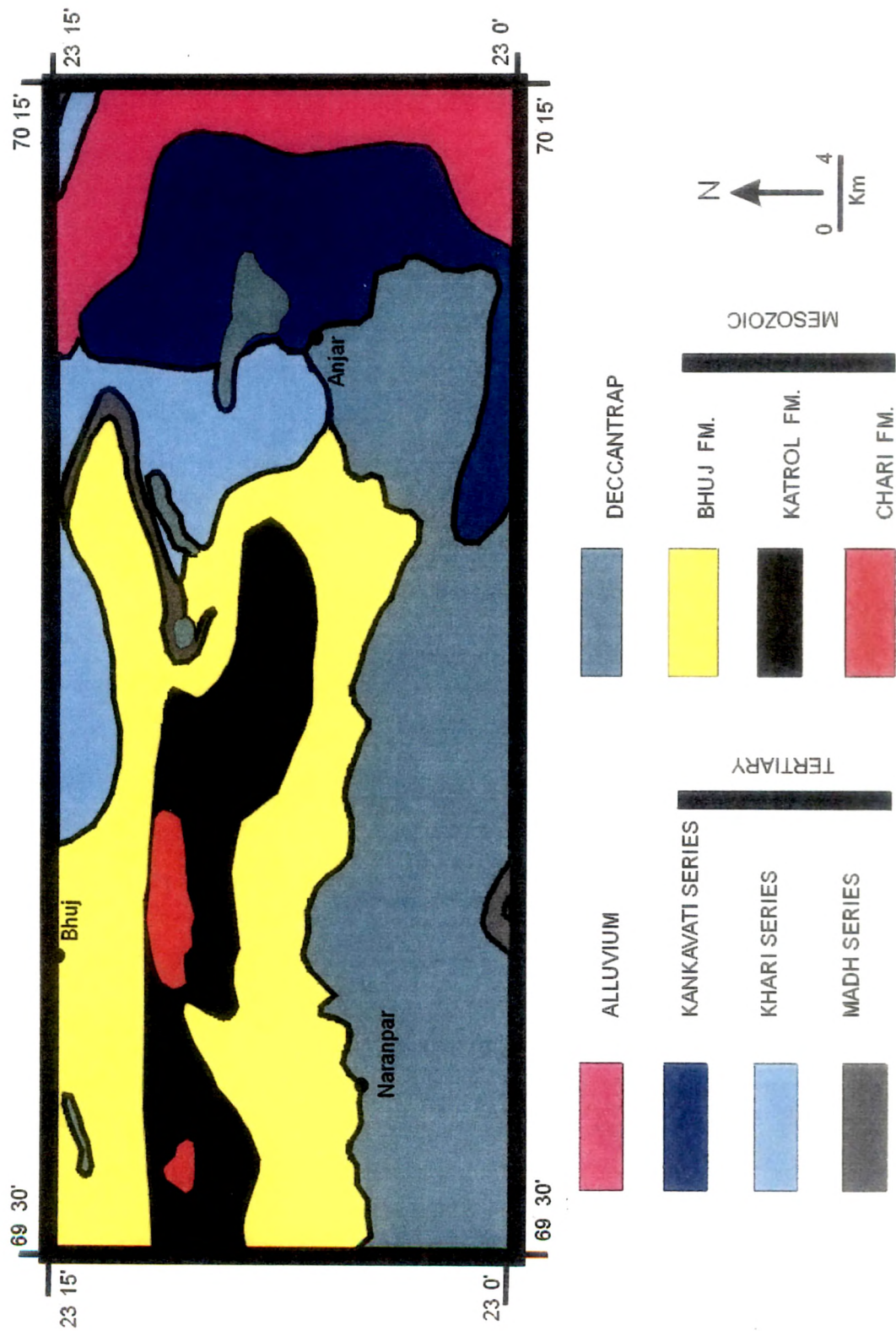


Fig. 1.6 Generalised geological map of the Study area (after, Biswas and Deshpande, 1970)

The central part of the area comprises the sandstones, Limestones and shales of Jurassic and Cretaceous age. These are seen intruded by the basic rocks of Deccan Traps. The Deccan basalts are exposed at the periphery of the Mesozoic rocks and are prominently exposed to the south of Katrol Hill range. The Tertiary rock exposures are not conspicuous, however, some exposures lie to south and eastern portion of the area. The Quaternaries are present in the form of Milliolite deposits in the highlands and as coastal deposits. The degree of rock exposures is fairly good. However, because of Low dips considerable difficulty was experienced while mapping the area.