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INTRODUCTION

CHAPTER 1

INTRODUCTION

PURPOSE AND SCOPE

The alluvial plains of mainland Gujarat constitute an important segment of the Quaternary terrain of Western India, and forms the Southern margin of the great Indian Thar Desert. It provides an insight into the late Quaternary depositional history, diverse climatic and tectonic activity. The central Gujarat plains are made up of huge thickness of marine and non-marine sediment successions, deposited under different depositional environment mainly, fluvial, aeolian and fluvio-marine. Three major rivers viz. the Sabarmati, the Mahi and the Narmada flow across these alluvial plains. The exposed sediment successions in these river valleys have preserved imprints of climatic fluctuations and tectonic episodes, that controlled the sedimentation pattern and were responsible for sculpturing the present day landscape. An interesting feature of these plains seen in all the river section is the striking similarity of the sediment sequences (Merh and Chamyal, 1993; Chamyal, 1995; Merh and Chamyal, 1997).

The Mahi basin is one of the major river basins of Gujarat alluvial plains. The Mahi river flowing across these plains has exposed the Quaternary successions in the form of cliffs ranging in height between 5 m - 35 m. These sediments not only provide information on the various sedimentary processes and related depositional environments but also help in reconstructing the late Quaternary palaeoclimate and

assessing the role of neotectonics. Previous workers mainly emphasized on archaeologic, geomorphologic, stratigraphic and to some extent on palaeoclimates. The lack of detailed sedimentological information has been a major lacuna in their work. The present study is primarily aimed at reconstructing the depositional history of the Mahi basin during Late Quaternary as revealed by the exposed sequences along the river. To achieve this objective, following aspects have been taken into account. (I) the sedimentological aspects of the exposed sediment successions and related depositional environments (II) climatic changes and tectonic adjustments that controlled the sedimentation pattern in the basin, (III) the change in channel morphology/planform and in sculpturing the present day landscape.

The investigations carried out by the author has brought out an interesting combination of the factors of climate, tectonism and base level changes in the Late Quaternary evolution of this basin. He has also been able to date the paleoclimatic and tectonic events with the help of TL dates. The new data generated in the present study has filled in many gaps in the existing knowledge of the Quaternary geology of the Gujarat alluvial plains in particular and western India in general.

APPROACH AND METHODOLOGY

The present investigation is based mainly on field data with supporting evidences provided by laboratory analysis. In the initial stages, the available information, both published and unpublished, was critically examined to get a

broad picture of the study area. Gaps in the existing knowledge were identified for executing the study in a meaning full way. Satellite images and Survey of India toposheets were studied for identifying major landforms, drainage characteristics and overall geomorphology of the area. These geomorphic features were mapped in the field and their interrelationships noted. The various exposed sections along the river were measured and studied for collection of data related to sedimentological and palaeoclimatic studies. Detailed lithologs were prepared and samples collected for laboratory analysis. Field characters of the various soils were examined and sampled for clay mineralogical studies. Systematic sampling of the type section located at Rayka was carried out for TL dating. Lateral profile studies were carried out based on field observations and with the help of Photomosaics to understand the lateral as well as vertical facies variations and to reconstruct the palaeochannel geometry and its characteristics. The tectonic activity has been worked out as manifested in the exposed sediments, based on the channel characteristic, channel morphology and related landforms. All observations and results of the investigations were synthesized to arrive at conclusions regarding the geological evolution of the study area.

STUDY AREA

The study area forms the (southern margin of the great Indian) Thar desert and lies between the two major rivers of mainland Gujarat, the Sabarmati in the west and the Narmada on the south. The Mahi basin covers part of the districts of

Kheda, Baroda and Panchmahals in Gujarat before meeting Gulf of Cambay. The study area is bounded by North latitude 22°10' to 23° 30' and East longitude 72°30' to 74°05' Fig. 1.1). The Mahi basin forms part of Survey of India toposheets nos. 46B, E, F, I and J (Scale 1:250, 000).

PHYSIOGRAPHY

The area is divisible into three distinct physiographic divisions viz. the rocky upland, the alluvial plains and the coastal plains. The total basinal area of the Mahi river is around 31,500 km^2. The part of Mahi basin in Gujarat on which this study dwells, comprises of area about 12,050 km^2 of which the rocky uplands covers an area about ~3600 km^2, alluvial plains ~7200 km^2 and coastal zone around ~1250 km^2. The area is flanked by Aravalli hills in the northeast and Panchmahal uplands in the east. The rocky uplands in the northeast consisting Aravalli hills range in elevation from 450 m -100 m, while a few isolated hills range from 80 m - 550 m (Fig. 1.2). These denudational landforms are marked by extensively folded hog-back ridges of quartzites, which at places show rounded tops and well-developed escarpments. The Panchmahal uplands comprise mainly trappean hills, elevation ranging between 170 m - 376 m. The Pavagadh hill located on the western side of the basin shows an elevation of about 857 m. The regional slope of the area is towards SW. The physiography of the area is variable, the alluvial plains are marked by undulating hummocky topography and the terrain becomes more rugged as one moves towards northeast and east of the area in rocky uplands. The

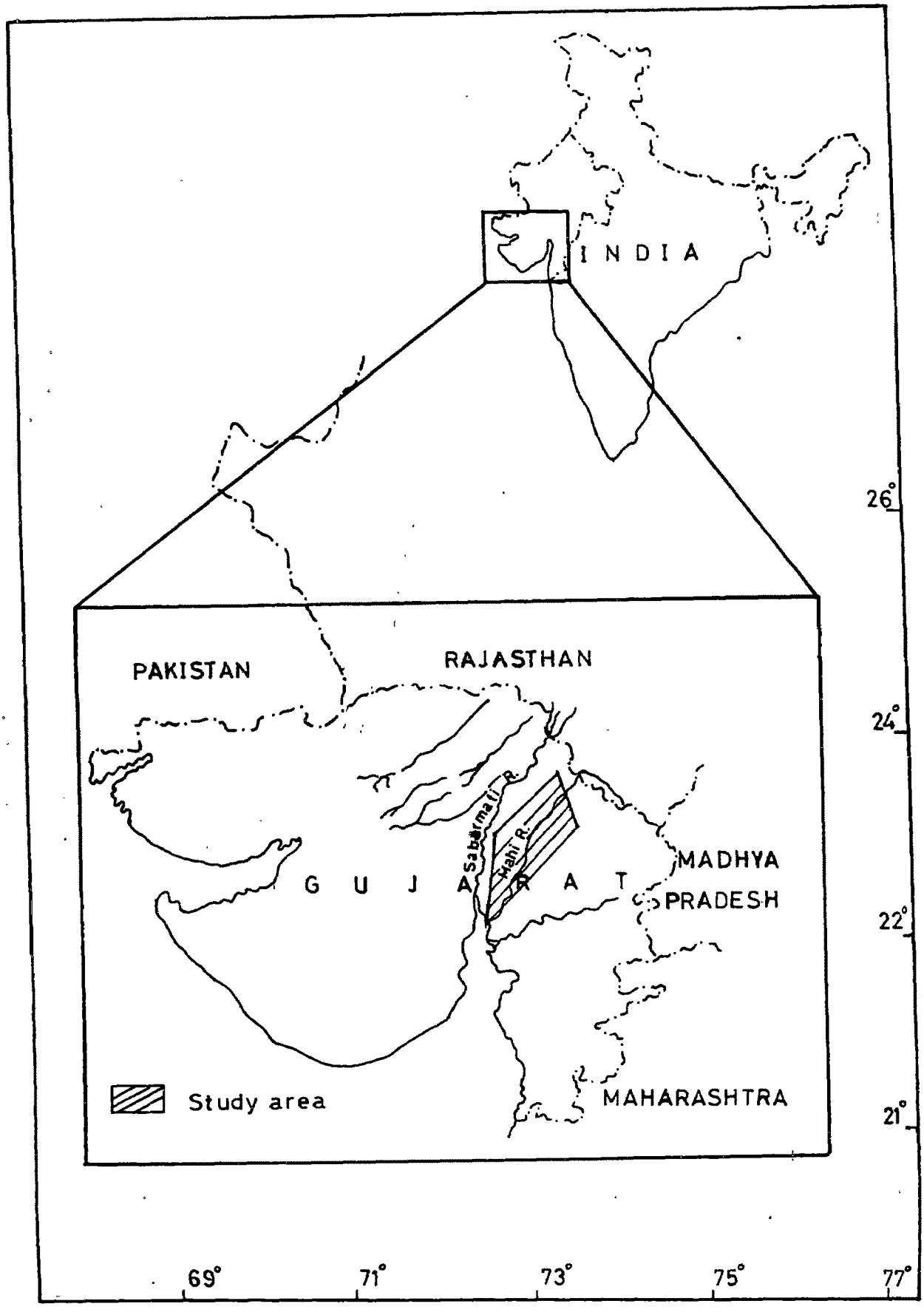

Fig. 1.1 : Location map of the study area

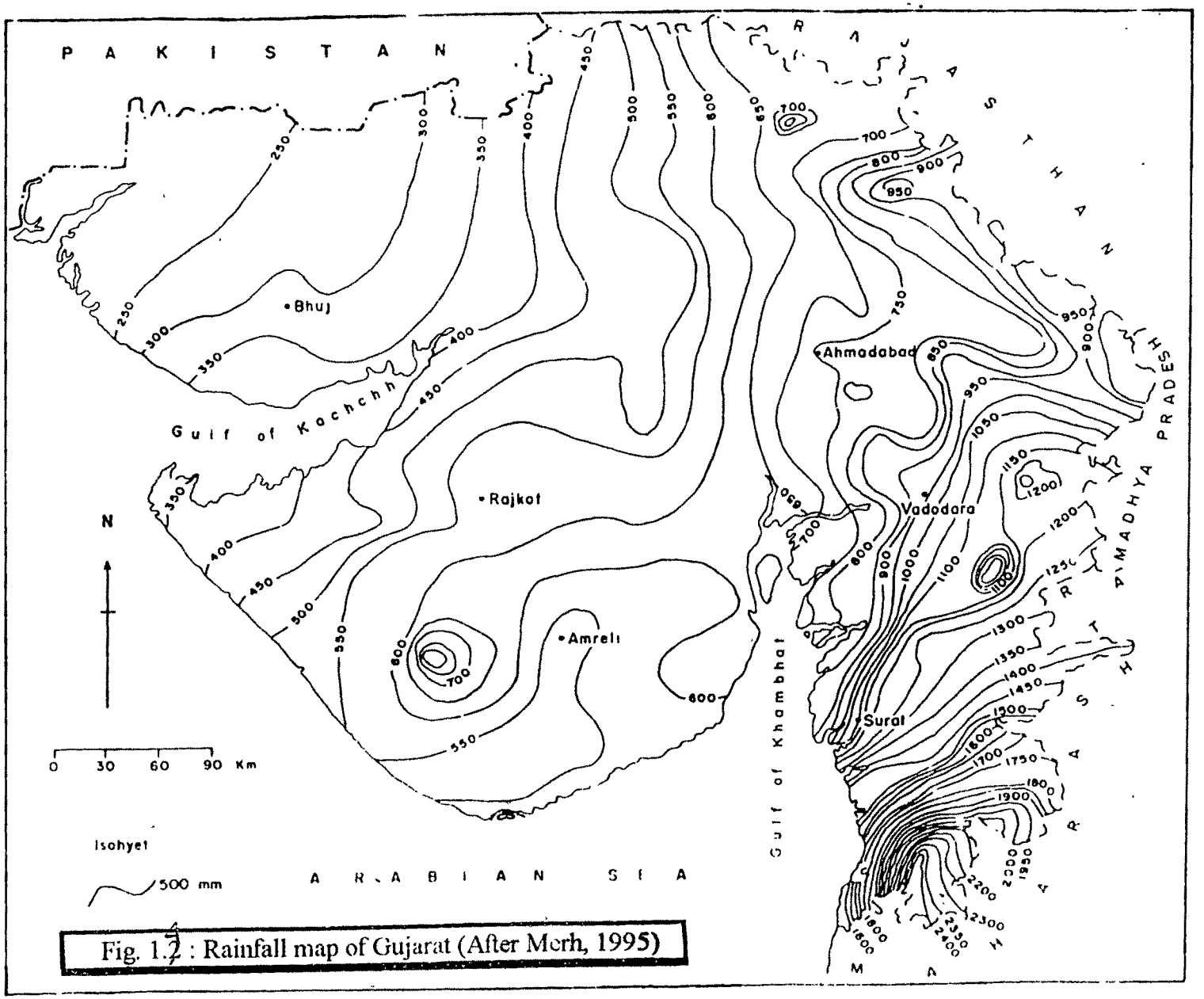

Fig. 1.2 : Rainfall map of Gujarat (After Merh, 1995)

alluvial plains mark the medial portion of the basin, confined between an elevation of 60 m - 20 m. The dunes occur as amorphous to aligned ridges on either sides of the Mahi valley ranging in height between 8 m - 10 m. Dunes as high as 15 m - 20 m are also observed on the right bank of Mahi around Dakor. The alluvial area shows a zone of intensive gully erosion confined to the valley sides. The gullies are as deep as 12 m - 15 m. The coastal zone forms the lower most portion of the Mahi basin and shows an elevation range of 20 m - 10 m. In this zone the Mahi is characterized by a broad estuarine mouth and highly sinuous channels, well-defined older valley margins.

DRAINAGE

The Mahi river originates from the Vindhyan hills (Malwa hills) near Gomanpur in Madhya Pradesh at an elevation of 556 m and after crossing the southwestern part of Rajasthan state flows through Khedapa, Kadana, Lunawada etc. of Panchmahal district of Gujarat. In the lower reaches, Mahi flows through southwestern portions of Kheda and Baroda districts before debauching into the Gulf of Cambay (Fig. 1.2). The Mahi river passes through the five major talukas of the Kheda districts viz. Vadasinor, Thasra, Anand, Borsad and Khambhat (Cambay). The total length of the Mahi river is nearly 500 km from its origin to its mouth. The river flows for a considerable distance in a rocky terrain before entering the alluvial tract. The length of the river in Gujarat is 275 km, of which about 165 km is in rocky uplands, while the lower reaches account for the remaining

110 km. The Mahi basin shows a remarkable asymmetry in terms of the tributaries meeting the main trunk channel. In the uplands some tributaries meet the main river from the right bank, whereas overall it has been noticed that all major tributaries and the related smaller streams are restricted to only the left bank. The major tributaries being the Som, Erau, Anas, Panam, Goma, Karad, Mesri and Mini.

GEOLOGY

The geology of Mahi basin comprises mainly Precambrian, Mesozoic and Tertiary rocks (Fig. 1.3). The basement rocks consisting of granites and gneisses are exposed on the eastern part. Major part of the catchment area of Mahi river is occupied by Precambrian Aravalli quartzites, phyllites, granites of Lunavada group, Champaner group and Godhra granite and Late Cretaceous Deccan basalts (Table 1.1). Some part of the area comprises granites (Upper Precambrian) sandstones and limestones (Lower Cretaceous/Bagh beds and Lametas) and outcrops of laterites (Upper Cretaceous).

CLIMATE

Gujarat, being located on the Tropic of Cancer, falls in the sub-tropical climatic zone and a large part of the state lies between 35 °C and 45 °C isotherms. The study area falls within the sub-humid and semi-arid zones and is marked by the variability of annual rainfall (650 mm - 800 mm in the lower reaches and 1000 mm - 1150 mm in the upper catchment area) (Fig. 1.4), and high annual temperature

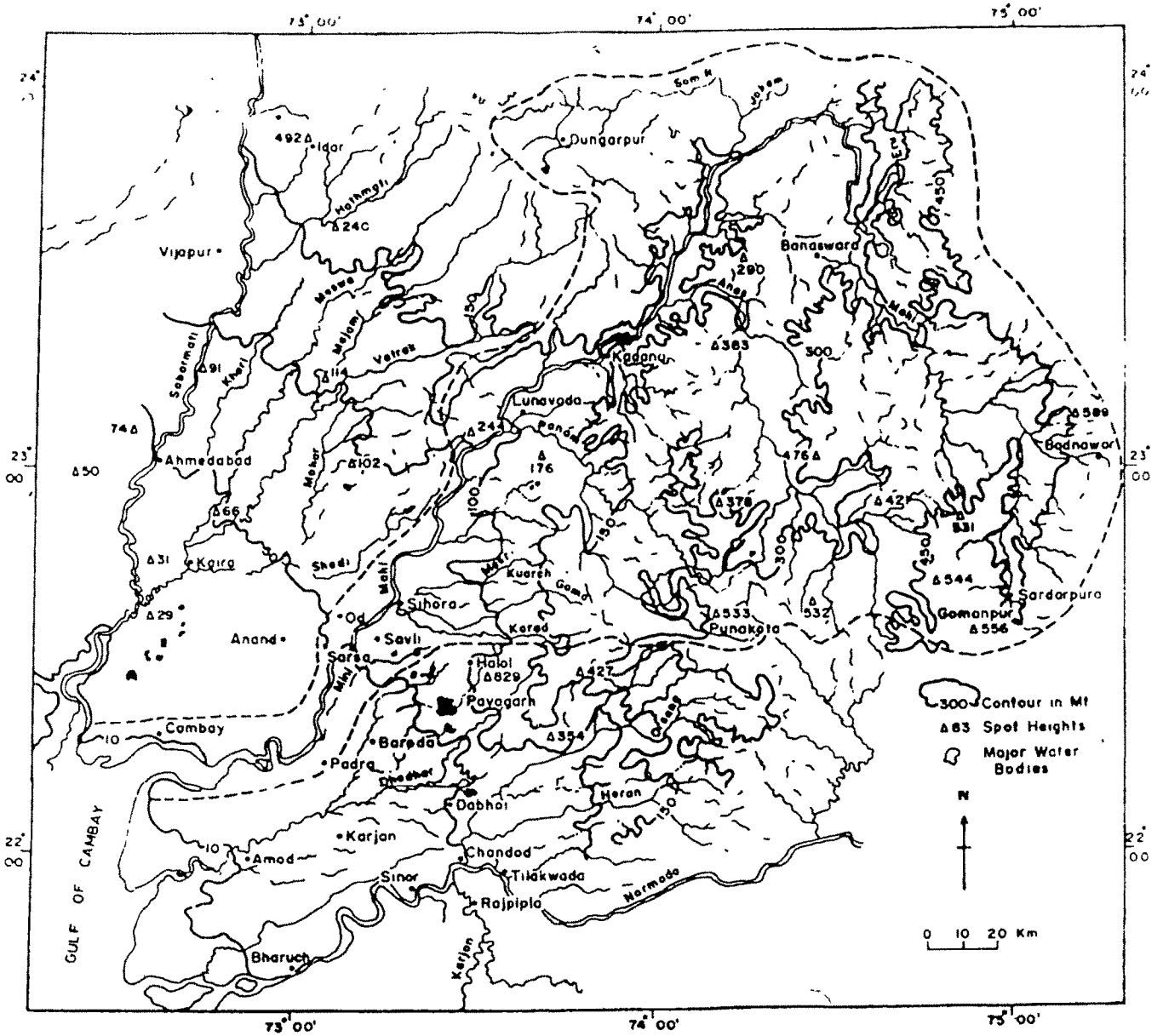

Fig. 1.2: Physiographic and drainage map.

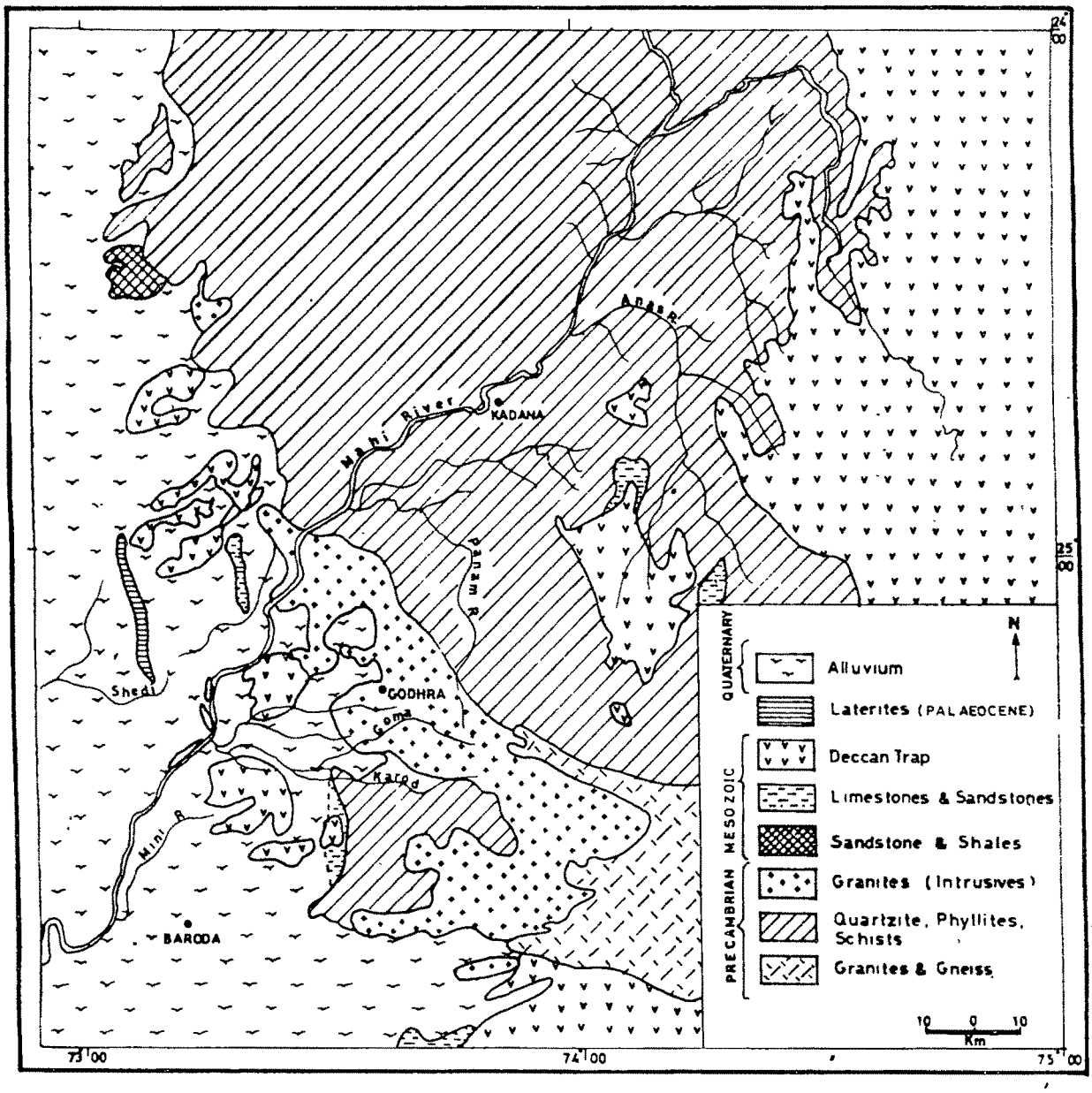

Fig 1.3. Geological Map of the study area (After G.S.I, 1975)

STRATIGRAPHY			MAINLAND GUJARAT	
ERA	PERIOD	AGE	GROUP / FORMATION	LITHOLOGY
CENOZOIC	QUATERNARY	HOLOCENE	GUJARAT ALLUVIUM	SAND, SILT CLAYS
		PLEISTOCENE U	NARMADA FM	WITH GRAVEL BEDS
		PLEISTOCENE L	JAMBUSAR FM (NOT EXPOSED)	COARSE SAND, CLAYS KANKAR
	TERTIARY	PLIOCENE U	BROACH FM (NOT EXPOSED)	CLAYSTONE SANDSTONE
		PLIOCENE L	JHAGADIA FM	CONGLOMERATE SANDSTONE
		MIOCENE U	KAND FM	CONGLOMERATE, FOSSIL LIMESTONE, CALC SANDSTONE
		MIOCENE L	BABAGURU FM	CONGLOMERATE SANDSTONE
		OLIGOCENE	?	? ?
		EOCENE U	DINOD FM	FOSSIL LIMESTONE MARL
		EOCENE L	VAGADKHOL FM	CONGLOMERATE GRIT SANDSTONE, CLAY SILTSTONE
		PALAEOCENE	LATERITE	BAUXITE BENTONITE
			DECCAN TRAP	THOLEIITE AND ALKALI BASALT
MESOZOIC	CRETACEOUS	U	DECCAN TRAP / LAMETA	FLOWS AND INTRUSIVES / LIMESTONE
	CRETACEOUS	L	BAGH BEDS / NIMAR SANDSTONE	LIMESTONE, MARL SANDSTONE
	JURASSIC	U M L		
PROTEROZOIC	POST - DELHI	MAGMATISM	MALANI VOLCANICS	ANDESITE ALBITISED BASALT
			ERINPURA GRANITE	POTASH GRANITE MICRO-GRANITE, GRANITE PORPHYRY
			GODHRA GRANITE	GRANITE, GRANITE GNEISS
			POST-DELHI-PRE-ERINPURA GRANITE PHASE	META - GABBRO META - DOLERITE, EPIDICRITE
	DELHI	SUPERGROUP	SIROHI GROUP	PHYLLITE, MICA-SCHIST CALC SCHIST
			AMBAJI GRANITE	GRANITE GRANODIORITE GRANITE GNEISS
			KUMBHALGARH GROUP	CALC SCHIST CALC GNEISS MICA SCHIST MARBLE
			GOGUNDA GROUP	QUARTZITE SLATE CALC SCHIST
	ARAVALLI	SUPERGROUP	CHAMPANER GROUP	SLATE, PHYLLITE QUARTZITE WITH MANGANESE
			LUNAVADA GROUP	PHYLLITE BIOTITE SCHIST QUARTZITE DOLOMITE
			RAKHABDEV ULTRAMAFIC SUITE	TALC-SERPENTINE SCHIST WITH TREMOLITE-ACTINOLITE
			JHAROL GROUP	PHYLLITE CHLORITE SCHIST GARNET MICA SCHIST QUARTZITE CRYST LST
	AGE UNCERTAIN		BASEMENT	GRANITE AND GNEISS

Table 1.1 : Stratigraphy of Mainland Gujarat

extremes. The climate in general is dry except for the monsoon season. The winter season starts from December and extends upto February. Summer approaches from March and peaks in May and June. The monsoon rain starts from the middle of June and continues upto September. The rainfall pattern (continuity, intensity and frequency) is of great importance for the Gujarat plains, particularly as they are situated on the margins of the Thar desert. In the area during the summer months, the mean daily maximum temperature is around 40 °C and mean daily minimum temperature around 25 °C, although temperatures touching peaks of 44 °C - 45 °C are not uncommon. Clear skies, low humidity and light northeasterly, northerly and northwesterly winds characterize the winter season. During the coldest month of January the normal minimum temperature varies from 7 °C to 18 °C (mean around 14 °C); occasionally the mercury dips below to 3 °C - 4 °C.

FLORA

The vegetation of the area varies very greatly in its different parts. The diversity is due to variations in rainfall, altitude, soil etc. The important timber and fuelwood species indigenous are Tectona grandis (Teak), Dalbergia latifolia (Sisam), Adina cordifolia (Hed), Mitragyna parvifolea (Kalam), Pterocarpus marsupium (Biyo), Acacia catechu (Khair), Gmehna arborea (Sewan), Grewia Tiliaefolia (Dhaman), Ougeinia oojeinenis (Tiwas), Garuga pinnata (Kakad), Lannea comandelica (Modal) and Acacia nilotica (Deshi-bawal). The exotic species are Eucalyptus tereticornis (Nilgiri), Casuarina equisetifolia (Saru) and

Prosopis juliflora (Gando-bawal). Mangifera indica (Ambo), Zizyphus mauritiana (Bordi), Feronia limonia (Kothu), Mimusops hexandra (Rayan), Annona squamosa (Sitafal), Phyllanthus emblica (Amlao), Syzygium cumini (Jambudo) are the main fruit trees. The important medicinal plants include Withania somnifera (Ashwagandha), Aristolochia bracteata (Kidamari), Cassia auriculata (Awal), Datura innoxa (Kalo daturo), Daemia extensa (Utarni), Evolvulas alsinoides (Kali shankhavali), Terminalia chebula (Harde), Terminalia bellirica (Beheda), Holarrhena antidysenterica (Kudi), Helicteres isora (Mararsinghi), etc. Among the oil-seed trees, important species are Madhuca indica (Mahuda), Derris indica (Karanj), Azadirachta indica (Limdo) and Salvadora oleoides (Pilu). The gum-yielding species are Sterculina urens (Kadaya), Boswellia serrata (Gugal), Commiphora mukul (Gugali) and Acacia nilotica (Bawal), etc. The leaves that are used as beedi wrappers are obtained from Diospyros melanoxylon (Timru), and Bauhima racemosa (Ashitra).

FAUNA

The chief domestic animals are, cow, buffalo, horse, camel, sheep, goat and ass. The important wild animals of the Cat family found in Gujarat are Panthera leo persica (Asiatic lion), Panthera tigris (Tiger), Panthera Paradus (Panther) etc. The panther, is found all over Gujarat. The wolf, jackal and fox, representatives of the dog family, also inhabit many forested parts of the state. Sambar, Indian gazelle, Black buck, Chital, Nilgai, etc. are the ungulates found in all the forest areas. Wild

boars are also found in large numbers. The smaller animals include the langur, jungle cat, mongoose, hare, civet cat, rattle shrew, hedge-hog, pangoline, porcupine, squirrel, gerbile and rat. Important reptiles found in Gujarat are marsh crocodile, python, variety of snakes (such as vipers, krates, water-snakes, wolf-snake, rat-snake), monitor-lizard, chameleon, garden-lizard etc. Important birds of Gujarat include peacock (National Bird), flamingo and the rare Great Indian Bustard. The common species of birds comprise crow, sparrow, parakeets, fly-catchers, babbler, bulbul, magpie, robin, drongo, oriole, myna, weaver-bird, swallow, wood-pecker, cuckoo, kingfisher, swift, owl, vulture, dove, sandgrove, partridge, saras-crane, egret, duck etc.

COMMUNICATION AND TRANSPORT

All parts of the study area are easily accessible as the state has a well developed communication and transport system (Fig. 1.5). Different parts of Gujarat state are connected by rail and road and the major cities are linked with other parts of the country by rail, road and air. Broad and Meter-gauge rail-lines of Western Railway criss-cross the entire Gujarat. The National Highway No. 8 pass through the study area and connects the major cities of Central, North and South Gujarat.

In addition, the region has a good network of State Highways and District roads. Most of the roads are good and motorable throughout the year. State Transport buses provide an efficient transport facility. Buses, taxis and three-

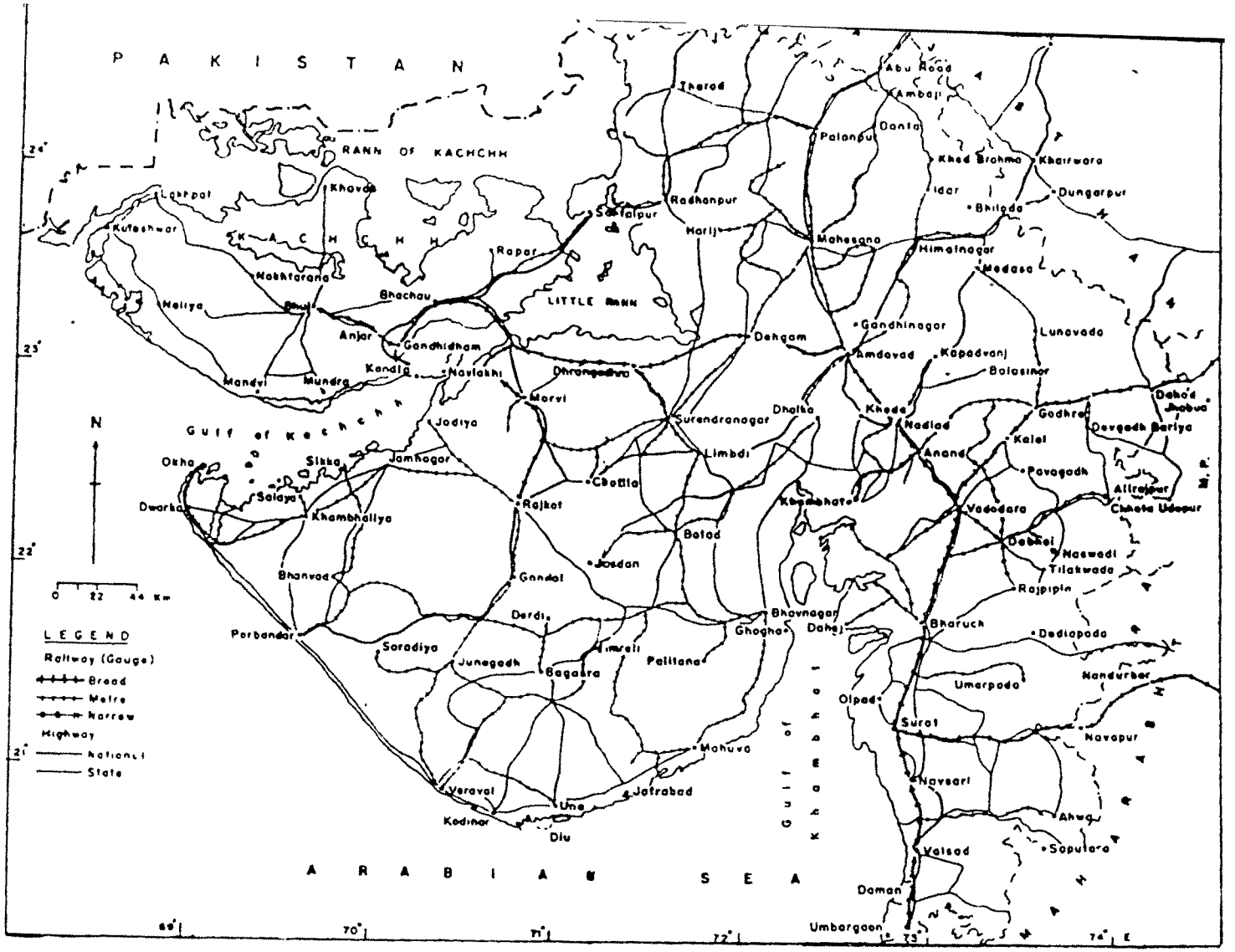

Fig. 1.5: Communication and Transport Map

wheeler autorickshaws ply on all the routes. Private buses are also easily available which can be hired for arranging specific journey requirements.