Chapter I

INTRODUCTION

1.0 PRELUDE

Human being, with a very short life span, has expanded his conception of the duration of time, in order to study his own planet earth and the various processes that are continually operating on it through geologic times. The coda of this geologic time, represented by the Quaternary period, is accorded with the highest interest and significance due to its proximity to the present age and most importantly, it is characterized by the emergence and development of the hominids.

The Quaternary period has witnessed series of frequent and rapid climatic changes along with epeirogenic movements, which in turn had continually modified the surface expressions of the continents. This second period of Cenozoic Era represents a total span of about 1.8 Ma and has been sub-divided into Lower Pleistocene (1.8 –

0.75 Ma), Middle Pleistocene (750 – 125 Ka), Upper Pleistocene (125 – 10 Ka) and Holocene (10 – 0 Ka) comprising thick accumulation of sedimentary deposits.

The south Gujarat alluvial plains, occupying a significant position along the western margin of Indian sub-continent, comprise considerable accumulation of these Quaternary sedimentary deposits. Owing to its uniqueness from the point of view of geomorphic diversity and climatic significance, these alluvial plains represent one of the most important and interesting segments of the west coast of India. Climatically, the south Gujarat terrain is represented by an overall humid tropical type, with a good seasonal rainfall and the presence of perennial river systems, characterized by a westward flow. These river systems, which form one of the most important geologic agents on the earth, had continually sculptured the landforms of south Gujarat terrain.

The northern portion of the south Gujarat alluvial plains is demarcated by the lower Tapi river basin (LTRB) i.e., the study area, which is characterized by the presence of Quaternary deposits. The LTRB has its own distinct identity in terms of sedimentation patterns vis-à-vis active tectonism and climatic vicissitudes. It is characterized by variety of landscape as well as tectonic features along with a well-developed drainage network. The LTRB also comprises an interesting assemblage of well-preserved palaeo-geomorphic landforms and tectonically accentuated features. However, a glance through the available literature has revealed that the LTRB has received less attention from the earlier workers and not much work is reported, except meager information merely highlighting the geomorphic setup of the south Gujarat as a whole. Hence an attempt has been made through the present study, to comprehend the role of various geological processes operating in the LTRB and also to envisage the overall sedimentation history vis-à-vis the role of neotectonism during the Quaternary times. Although these geological processes seem to be infinitely slow today, but over a

period of several thousands of years, have resulted in the present-day landscape configuration.

The LTRB is located on the threshold of semi-arid and humid climatic domains and its northern and southern boundary is distinctly demarcated by the presence of Kim and Purna rivers respectively; whereas the trappean highlands and the Arabian sea delimits its eastern and western boundary respectively. The LTRB constitutes a thick pile of Quaternary sedimentary deposits resting unconformably over the Tertiary and Trappean basement. Tectonically, the LTRB forms a part of the two major peri-continental rift basins i.e., the Cambay and the Narmada rift basins, which seems to have governed its tectonic setup. It is also evident that the episodic reactivation along these tectonic elements coupled with the climatic perturbations, have controlled the sedimentation pattern and geomorphic evolution of the landforms in the LTRB.

Owing to this, a multi-disciplinary approach has been adopted in the present study to understand the intricacies related to the Quaternary sedimentation in the LTRB. The combined evidences from the extensive field observations, sub-surface bore-hole data, precise laboratory investigations and various other persuasive studies, have helped in the reconstruction of the basin configuration of the LTRB, its sedimentation history and the governance of tectonism over it, during the Quaternary times.

1.1 AIMS AND OBJECTIVES

The present study is aimed to work out the evolution of the LTRB, Quaternary sedimentation history and the role of neotectonism. In order to achieve this, the following objectives have been considered.

1. To understand the geological setup of the study area in totality and to reconstruct an integrated stratigraphic record of Quaternary sediments.

2. To work out the detail geomorphology of the study area in order to understand the process dynamics vis-à-vis palaeo-geographic reconstructions.
3. To study lateral as well as vertical facies distribution of Quaternary sediments in LTRB, and to envisage the overall sedimentation history.
4. To understand the role of neotectonism in the LTRB and its control over the Quaternary sedimentation records and geomorphic attributes.

1.2 THE STUDY AREA

1.2.1 Location and Extent

The Lower Tapi River Basin lies between N21^{0}05'; N21^{0}30' latitudes and E72^{0}37.5'; E73^{0}30' longitude (Fig. 1.1) and falls within the Survey of India topographic maps number 46C/11, C/12, C/15, C/16, G/3, G/4, G/7, G/8.

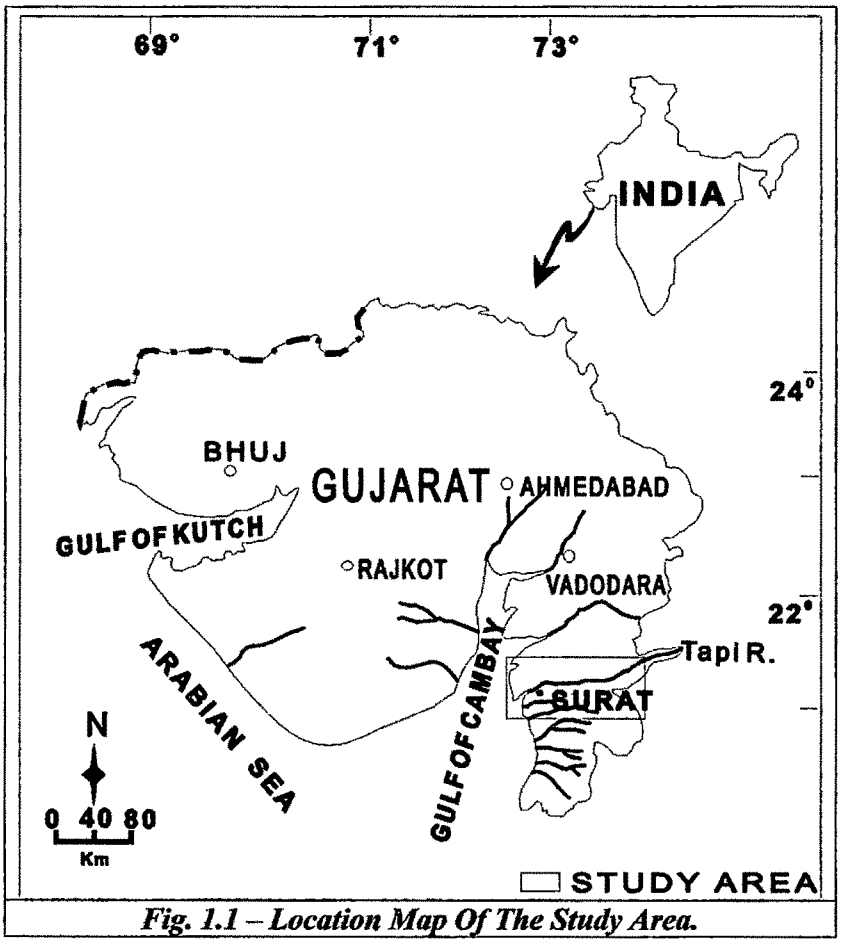

Fig. 1.1 – Location Map Of The Study Area.

Physiographically, its northern and southern limits are bounded by the Narmada and Purna rivers respectively. The western extent is delimited by the Arabian sea, and in the east, the area extends up to the base of trappean plateaus of Deccan basalts. The LTRB has an approximate rectangular shape with E – W length of about 98.92km and N – S width of about 58.22km, covering an overall area of approximately 5759 sq. km.

1.2.2 Physiography

The physiography of the study area aptly represents the landform features formed partly due to the differential weathering of Deccan traps and also on account of the tectonism.

On the basis of the altimetric variation, the study area has been divided into four physiographic zone, viz. (i) Inner Trappean Highlands (>100m Above Mean Sea Level), (ii) Upper Pediment Zone (50-100m Above Mean Sea Level), (iii) Middle Alluvium Plains (10-50m Above Mean Sea Level) and (iv) Lower Coastal Zone (<10m Above Mean Sea Level).

(i) The Inner Trappean Highlands – This zone is marked by highly irregular topography formed on account of differential weathering of Deccan traps, comprising hills, which do not exceeds an elevation of 150m height, with associated narrow intermountain valleys.

(ii) Upper Pediment Zone – This zone is a transitional one that directly abuts with the trappean highlands, characterized by a moderate relief and westerly slopes. This zone shows a rolling topography and falls within the rocky domain of Deccan basalts, with a considerable thickness of colluvial materials.

(iii) Middle Alluvium Plain – This zone is characterized by a vast planation surface comprising thick accumulation of flood plain deposits resting over the trappean

terrain and bounded by moderate – steeply sloping pediment zone in the east and a narrow coastal plain strip in the west.

(iv) Lower Coastal Plain – This zone represents lower planation surface, distinguished by an extensive thickness of fluvio-marine and top-aeolian materials. This zone is characterized by the presence of sandy beaches, bars, barrier ridges, creeks and mudflats.

1.2.3 Drainage

The study area is drained by the present-day mega fluvial system of river Tapi and its tributary streams along with Mindhola and Kim river systems. These rivers are westerly flowing and originate from the highland zone, except river Tapi, which originates further east, from the highlands of Madhya Pradesh, and ultimately meets the Arabian sea in the west.

The Tapi river, being perennial remains full of water through out the year, whereas Mindhola and Kim rivers show gradual decrease in quantity of water, in the seasons other than monsoon.

The main rivers along with their tributary streams and other lower order streams are strongly influenced by the E – W fracture patterns dominating the study area.

1.2.4 Climate

The study area being located in the proximity of Tropic of Cancer falls in the sub-tropical climatic zone, characterized by humid to sub-humid conditions. The area experiences a hot summer and general dryness, except during the period between June and September, when the southwest monsoon prevails. During the peak summer i.e. from March to May, the mercury level rises up to a maximum of 46^0C, however

during the winter months i.e. November to February, it drops down to 8^0C. The study area experiencing a moderate rainfall forms a transitional zone between the heavy monsoon area of south Gujarat and the semi-arid areas of north Gujarat. The area receives its rainfall entirely from the Arabian sea monsoonal currents with an average annual rainfall of 1282mm.

1.2.5 Transport and Communication

The study area is well connected by road and railway networks. The National Highway (No. 8) as well as the State Highways, along with interconnected mettled and unmettled roads criss-cross the study area and connects it with major cities and towns of the adjoining regions and the country. Surat, which is the major city and railway station of the study area, lies on the broad gauge Delhi – Mumbai (Western Railways) and Surat – Bhusawal (Central Railways) railway lines.

1.3 APPROACH AND METHODOLOGY

Taking into account, the aim of the present research, a multi-disciplinary approach was adopted for the accomplishment of the proposed objectives. The detail methodology is cited as follows:

1. A thorough review of the available literature on various aspects, pertaining directly or indirectly to the study area has been carried out.
2. Detailed study of Survey of India topographic maps and the digital satellite data (IRS 1C LISS III, 1998) has been undertaken in order to delineate various terrain attributes, particularly the drainage network, present & past geomorphic features, lineaments etc. The data obtained from these studies have been confirmed by means of ground truth/field check.

3. The fieldwork component includes:
    I. Delineation of the lateral and vertical extent of the Quaternary sediments of the study area and understanding their nature of disposition.
    II. Borehole records (>200) of the study area in particular and south Gujarat in general have been observed to understand the sub-surface distribution of the Quaternary sediments. This is done by means of fence diagrams, stratigraphic maps and sub-surface profiles.
    III. Vertical litho-stratigraphic successions have been prepared, and representative samples of each of the lithological units have been systematically collected at regular intervals. Various primary as well as secondary structures have been observed and appropriately interpreted.
4. The representative samples collected from the field have been treated for laboratory investigations. This includes the observation of samples under binocular microscopes, granulometric analyses, petrographic studies, surface texture studies using Scanning Electron Microscope, bulk as well as clay mineralogy using X-Ray diffractograms, trace element estimations and palaeontological studies
5. The results obtained from the field observations as well as the laboratory data have been interpreted and integrated in order to bring out the Quaternary basin evolution, sedimentation history vis-à-vis tectonism in the LTRB.