Chapter VII

QUATERNARY SEDIMENTATION HISTORY

7.0 INTRODUCTION

The preceding chapters of the present study have provided an elaborate information of the observations made on the nature of exposed Quaternary sediments of Lower Tapi River Basin (LTRB), their lateral as well as vertical distribution, field characteristics, geomorphic and tectonic vicissitudes and laboratory details. The contents of this chapter mainly focuses on the integration and interpretation of the results to bring out a comprehensive picture of the sedimentation history during Quaternary – Holocene times, encompassing pre-Quaternary basin configuration, stratigraphy, depositional environments of the sediments vis-à-vis the role of tectonism, sea level fluctuations, climatic changes and geomorphic processes.

7.1 QUATERNARY BASIN CONFIGURATION

Sedimentary basin, in a very broad sense is all those areas in which sediments can accumulate to considerable thickness and be preserved for long geological times (Einsele, 1992). In a plan view, sedimentary basin can acquire different shapes such as circular or more frequently, elongate depressions, troughs or embayment, but often they may have quite irregular boundaries.

To understand the configuration of LTRB and the factors that governed its evolution during the Quaternary times, it is inevitable to assimilate the information pertaining to the overall litho-tectonic set-up and palaeo-geographic conditions prevailing during that time.

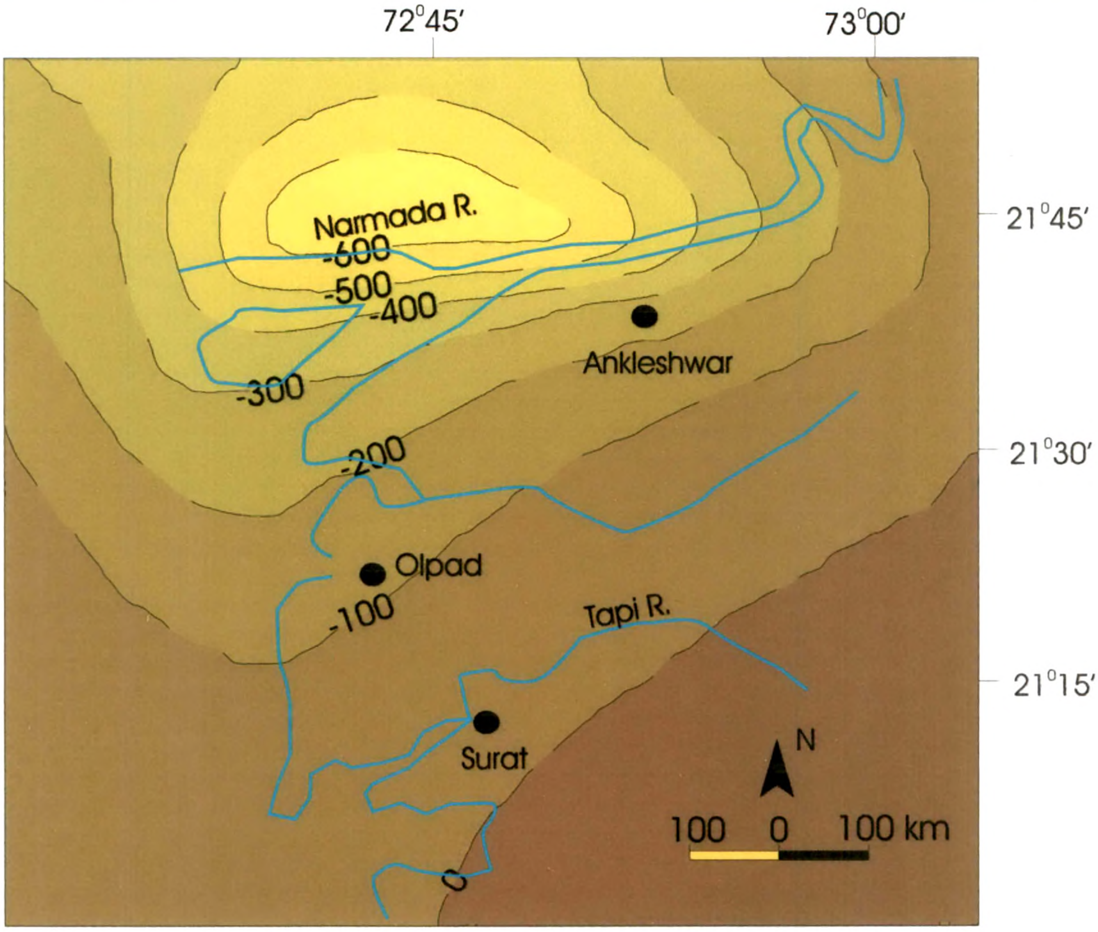
The present-day surficial geology of the study area shows that the Quaternary and the Holocene sediments rest unconformably on the erosional surfaces of Deccan Traps (upper Cretaceous to Eocene) in the southern and eastern parts and partly on the Tertiary sediments (Kand Formation – Middle to Upper Miocene) in the northern portion. Along with the surface geology, the sub-surface data on Quaternary sediment distribution obtained from bore-hole records and Deep Seismic Sounding (DSS) profiles, has supplemented relevant information, which have been utilized in understanding Quaternary basin configuration. Taking into account the surface as well as sub-surface disposition of Quaternary sediments in the study area, it is clear that the erosional surfaces mainly of Deccan Traps and at places, Tertiary sediments (Kand Formation) have provided platforms for the deposition of these sediments.

The regional tectonic history has clearly pointed out that the study area and its environs witnessed several episodes of tectonism and eustatic changes, thereby causing changes in the basin configuration from time to time. In order to understand the role of these causative factors and their impact on the overall basin configuration, attempt has been made to construct the structure contour and isopach maps for the basement as well as Quaternary sediments.

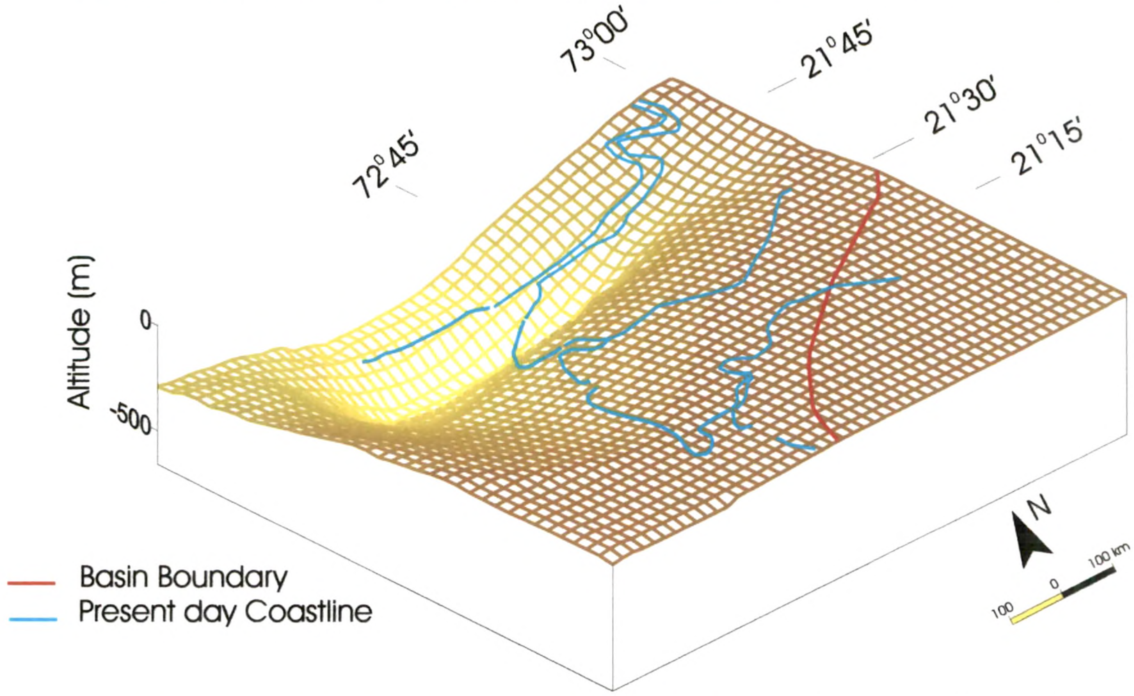
The isopach map prepared for the Kand Formation (Fig. 7.1) based on the bore-hole data (Pandey et al. 1993), indicates that the depositional basin was almost in the north of the existing Tapi river. The orientation of this basin is found to be almost E – W, elliptical in nature, with constant slopes on all sides. This map also indicates that during the deposition of Kand Formation, in the middle Miocene times, the depocenter was almost confined in the WNW direction accommodating deposition of more than 200m.

The structure contour and isopach maps of the Quaternary sediments (Fig. 7.2 and 7.3), prepared on the basis of sub-surface bore-hole information obtained from various state government organizations, indicate the change in the basin configuration having a general basinal slope towards west to southwest with a shift in the depocenter from northwest to southwest direction. The shift in the depocenter from WNW direction during the upper Tertiary times to southwest in the Quaternary times is very well attributed to the differential block movements along the E – W transverse fault systems. It is very much likely that the differential block movement perhaps caused the upliftment of the Narmada – Kim block along with the concomitant subsidence of the Tapi block. The Eastern Cambay Basin Marginal Fault as well as the West Coast Fault systems seems to have significantly contributed towards the subsidence of this block.

It is envisaged that the tectonic reactivation along these active fault systems must have been the causative factors for the syn-sedimentary accumulation of the Quaternary sediments in the Tapi river basin.



Isopach Map of the Kand Formation (Modofied after Pandey et al. 1993)



Block Diagram Representing 3-D Basin Configuration During Middle Miocene Times (Kand Formation)

Fig. 7.1 - Isopach Map And Basin Configuration During Middle Miocene (Kand Formation).

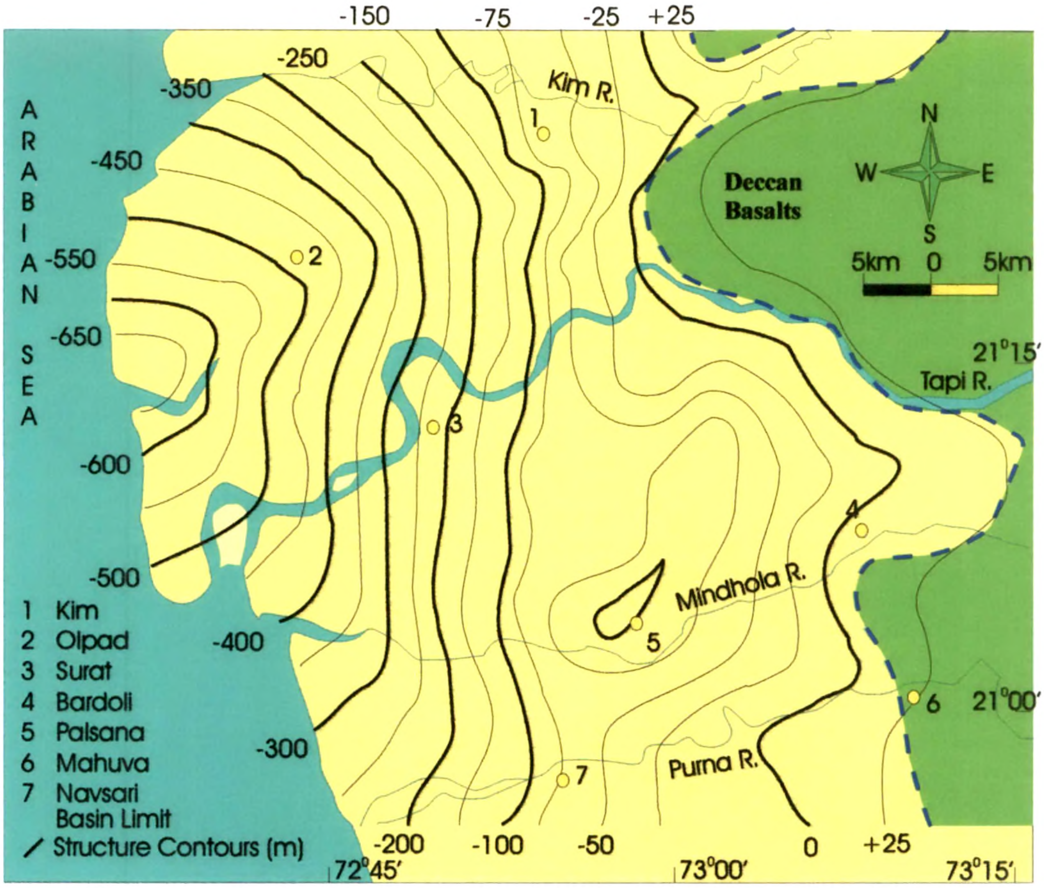


Fig. 7.2 - Figure Depicting The Structure Contour Map Of The Quaternary Sediments Of LTRB.

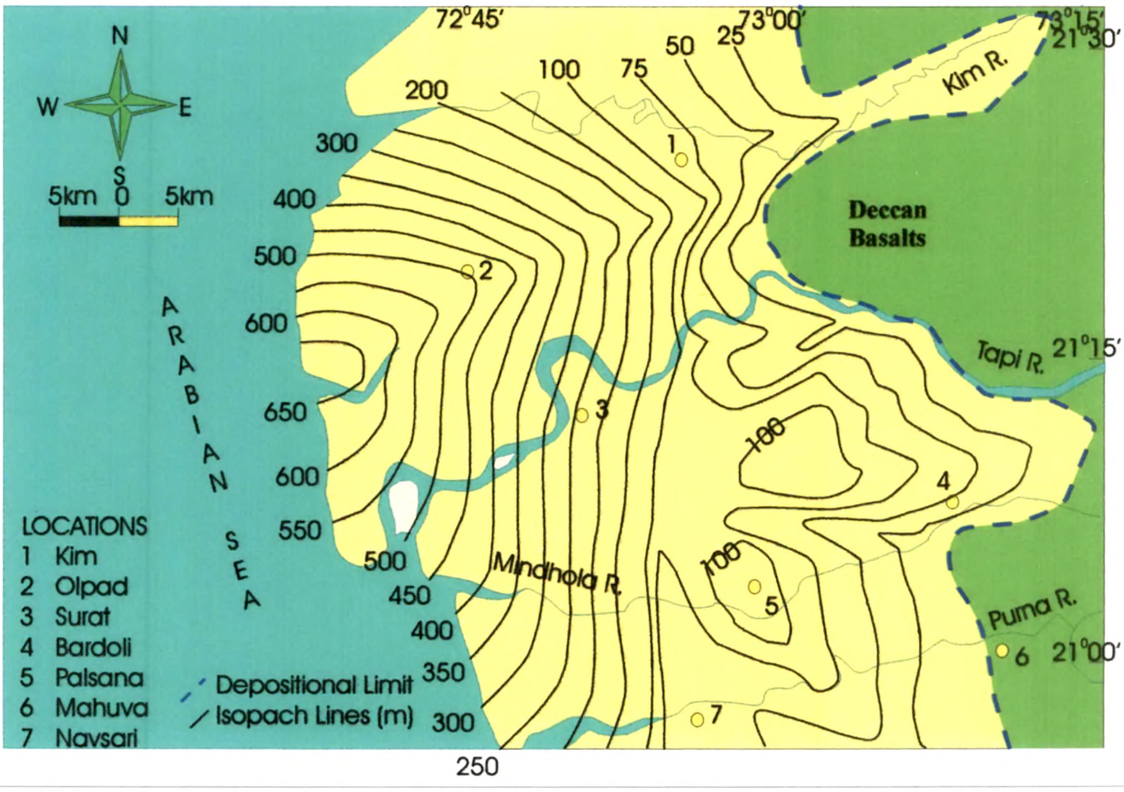


Fig. 7.3 - Figure Depicting The Isopach Map Of The Quaternary Sediments Of LTRB.

Interestingly, the absence of the early Pleistocene sediment record as surficial outcrops in and around the study area strongly indicates a rapid subsidence of the Tapi basin during the early Pleistocene times. Ramanathan and Pandey (1988), based on their studies on the Neogene – Quaternary boundary in the western Indian shelf, have envisaged a regressive phase during early Pleistocene times and have documented the presence of early Pleistocene sediments in the sub-surface stratigraphy of Hazira – 1 well (Fig. 7.4). They have further opined that the Neogene – Quaternary boundary is difficult to establish in Gujarat on account of the paucity of key taxa and faunal control. Based on the field investigations of the exposed surficial outcrops of Tertiary and Quaternary sediments of the study area, it is very well envisaged that the continental Quaternary history of the lower Tapi river basin initiates from middle Pleistocene onwards. This is further supported by the observations carried out by Sali (1973). Based on the archaeological evidences, he opined that the Quaternary deposits of central Tapi basin in Maharashtra range in age from Middle Pleistocene to Holocene.

The study carried out on the palaeo-geomorphic features and the basin configuration strongly suggests the role of tectonism and eustatic changes (Table 7.1). Particularly, the palaeo-lobatic features, which have been identified to be the river dominated fan shaped deltas, strongly reflect the land-sea boundary conditions persisted during those times. These palaeo-geomorphic features, along with the litho-stratigraphic successions aided with the overall tectonic set-up have helped to decipher the palaeo-strandline positions in and around the study area during Quaternary times.

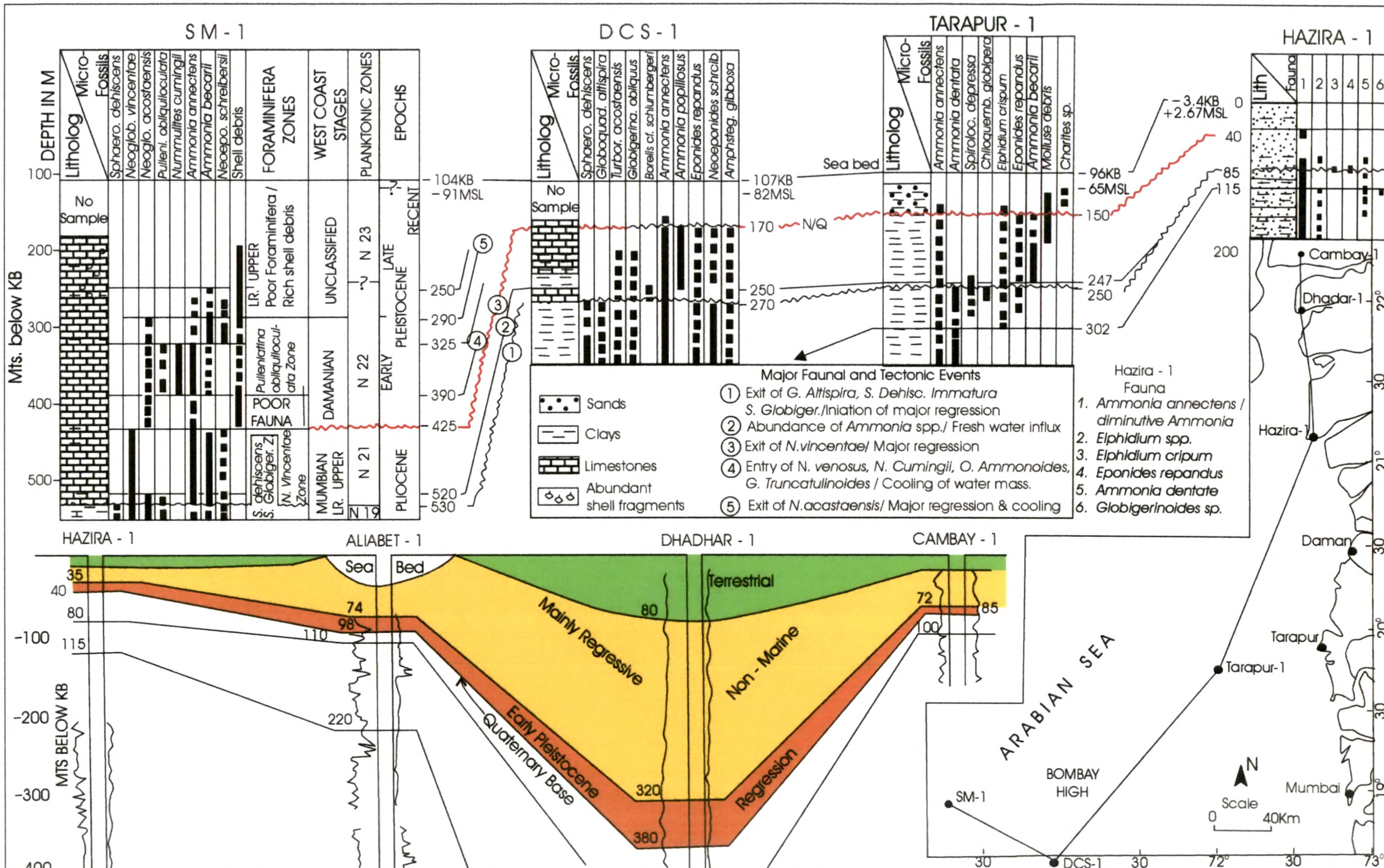


Fig. 7.4 - Diagram Showing The Neogene - Quaternary Transition In The Western Indian Shelf (Modified After Ramanathan and Pandey, 1988).

Age	*Period*	*Tectonic Events Inferred In LTRB*	*Global Sea Level Changes*	*Palaeo-geomorphic Features In LTRB*	*Inferred Sea Level Changes In LTRB*
~<4 Ka	Late Holocene	Uplift	Regression	Tapi lobe-IV	Fall
~6 – 4 Ka	Middle Holocene	-	Transgression (+5m)	High Marsh	Rise
~10 – 8 Ka	Early Holocene	Subsidence	Regression (-150m)	Tapi lobe-III	Fall
125 – 10 Ka	Upper Pleistocene	Uplift	Regression	Tapi lobe-II	Fall
750 – 125 Ka	Middle Pleistocene	Subsidence	Transgression (+40m)	Tapi lobe-I	Rise
1.8 – 0.75 Ma	Lower Pleistocene	Uplift	Regression	-	Fall

Table 7.1 – Tectono-Eustatic Changes In The Lower Tapi River Basin During The Quaternary Times. ***[Global sea level changes on the basis of Fairbridge (1972); Shackleton and Opdyke (1973) and Chappell and Shackleton (1986)]***

(i) ***Middle Pleistocene*** – The Lobe-I of Tapi river with its apex at 41m elevation along with its distributory channels represents the land-sea boundary during the middle Pleistocene times, which is in accordance with the high sea strand of 40m suggested by Tricart (1971) and Ganapathi et al. (1981). It is very important to mention here that even though the middle Pleistocene period, represents overall transgression, however within the study area the advancement of sea further east seems to have been restricted on account of huge sediment input contributed by the active drainage network of palaeo-Tapi and its tributaries.

(ii) ***Upper Pleistocene*** – The Lobe-II, which encompasses the present-day mouth of Kim river, represents shift in the land sea boundary during the upper Pleistocene times. This is attributed to the tectono-eustatic changes and the subsequent shift of Tapi river channel in the northwest direction.

(iii) ***Upper Pleistocene to Holocene*** – The continual regression from upper Pleistocene to early Holocene has resulted in the development of Lobe-III, indicating further change in the land sea boundary and anomalous behavior of

Tapi river in terms of its shifting in the southwest direction, which is well attributed to the reactivation of Tapi fault. However, during the middle Holocene times on account of the rise in the sea level attributed to the Flandrian transgression (Merh, 1987), the land sea boundary seems to have shifted to further east. This is clearly indicated by the presence of raised mudflats along the coastal segments of the study area. According to Chappel and Shackleton (1986) and Marathe (1995), during the last glacial stage (10 – 15 Kyrs), the sea level had gone down to -150m. Further Marathe (Op. cit.) suggested that this regression continued up to 11,000 B.P., which was followed by transgression during Holocene. The sea level raised by +6 to +8m between 6000 and 4000 yrs B.P.

(iv) ***Recent to Sub-Recent*** – In the late Holocene, the regression seems to have resulted in the formation of Lobe-IV, which currently represents the present-day river mouth of Tapi and Mindhola rivers.

On the basis of various inferred palaeo-strandline positions along with the presence of palaeo-geomorphic as well as the major tectonic features, an overall model depicting the palaeo-geographic set-up of the LTRB and the chronological stages of the development of the associated palaeo-lobatic features during the Quaternary times, have been envisaged (Fig. 7.5).

Along with the understanding of basin evolution and the land-sea boundary conditions, it is equally important to decipher the palaeo-geographic conditions and the overall behavior of the drainage network for a precise understanding of the sedimentation history. The isopach map of the Tertiary sediments in the study area and their surface as well as sub-surface distribution, indicates that the basin must have been dominantly restricted between Narmada and Tapi fracture systems with the basinal slope towards WNW.

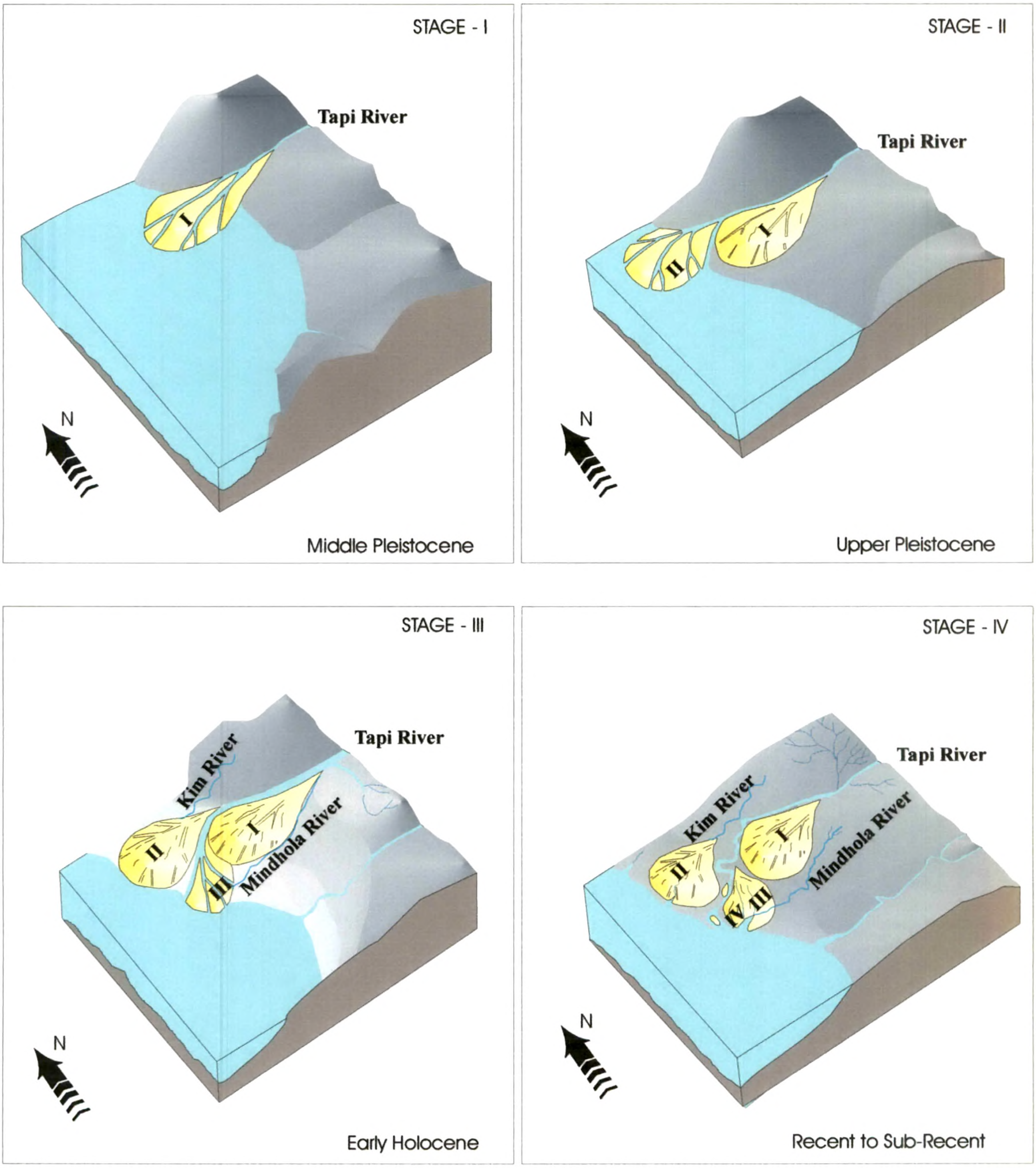


Fig. 7.5 - Schematic Representation Of Stages Of Development Of Palaeo-Lobatic Features During Quaternary Period In LTRB.

It is quite likely that the drainage network of Narmada and Tapi rivers during that time had followed the general basinal slope and actively contributed to the Tertiary deposition. This further suggests that the eastern and southeastern portions of the basin not only acted as positive areas but also as barriers, restricting the extension of Tertiary deposition. This is well attributed by the absence of Mio-Pliocene sediments belonging to Jhagadia and Broach Formation in the surface as well as sub-surface records, however, they are well exposed in the northern parts of the present-day Tapi river.

The post-Pliocene times seem to have experienced appreciable tectonic upheavals resulting in the block movements and the change in the basin configuration, which is well reflected in the structure contour and isopach maps. The post-Pliocene tectonism is clearly reflected by the presence of large scale deformational features in terms of domes, basins and folding within the surface outcrops of Jhagadia and Broach Formations (Gadekar, 1975; Agrawal, 1984). The changes brought about in the basin configuration on account of the block movements resulted in the subsidence of the Tapi block, paving the way for the Quaternary sedimentation. The presence of a thick accumulation (650m; Pandey et al., 1993) of Quaternary sediments in the sub-surface data suggests that the subsidence and sedimentation occurred concomitantly.

Based on the observations cited so far, it is quite clear that the continental Quaternary sedimentation in the study area seems to have initiated during middle Pleistocene times onwards. Although evidences of early Pleistocene sediments in other parts of Gujarat have been suggested by Merh (1993), however, so far no surficial evidences of the correlatable sediments have been noticed in the present investigation. Since the beginning of the Quaternary has been marked by active subsidence and sedimentation, the possibility of the presence of early Pleistocene deposits in sub-surface geology of the study area cannot be ruled out however, this aspect remains a matter of further investigation.

7.2 DEPOSITIONAL ENVIRONMENTS

A sedimentary environment is defined as a complex of physical, chemical and biological conditions under which sediment accumulates and determines the property of sediments deposited within the environment (Krumbein and Sloss, 1956).

The exposed continental Quaternary sedimentary successions within the study area representing the depositional record from middle Pleistocene onwards, have been thoroughly investigated from the point of view of understanding the various processes that have actively participated during the sedimentation. The field observations as well as the laboratory studies of these sediments described in the preceding chapters of this dissertation have sufficiently furnished relevant information for the interpretation of the environment under which these sediments have accumulated and the role of associated geological processes.

The observations carried out on the exposed sedimentary successions in the study area indicate that the sediments have been derived mainly from the Deccan Traps and the Tertiary Formations. These sedimentary successions, in the lower as well as the middle reaches of Tapi river basin have been found resting unconformably over the erosional surfaces of Deccan Traps and at places, the Tertiary rocks (Kand Formation), with varying thicknesses. The variation in thickness of these sediments is attributed to the palaeo-topography and the nature of the sub-stratum. The lithological units, generally exhibit horizontal attitude however at places, in the middle as well as the lower reaches of the basin, they show an inclination of about $20^0 - 25^0$ towards southwest. It is also observed that the sedimentary layers at places, show evidences of minor dislocations and thrusting of the layers on local scale. All these evidences indicate the role of post-Quaternary tectonism. The sedimentary successions observed at several locations in general, show well laminated units representing cycles of fining upward sequences, comprising the clastic accumulation of gravels, sands, silts and clays, wherein the later units dominates. Apart from the laminations, primary sedimentary structures observed within the sand units include the planar as well as the trough cross-stratifications. The angle of inclination and the length of the cross-sets aptly points to their formation on account of fluvial processes (Pettijohn, 1984). The sub-angular to sub-rounded nature of the clasts, their composition and the degree of sorting represents the proximal source. The overall sedimentological characteristics and the fining upward nature of the sediments points to their deposition under fluvial conditions representing a channel fill – point bar – floodplain deposits.

The vertical stratigraphic successions observed at various locations have exhibited the process of calcretisation within the units. However, a complete sequence of calcretisation has not been observed through out the study area. The calcrete profile observed at Dhatwa location in the lower reaches of the basin shows a comparatively appreciable sequence of calcretisation from calcified soil to the indurated forms (hardpan variety). The nature of the calcretes, their field occurrences and the sequence of development, points to their non-pedogenic nature and seems to have been the result of lateral seepage of through flowing streams and groundwater.

The laboratory investigations carried out for the Quaternary sediments of the study area have provided interesting results, which strongly support field observations, thereby indicating the nature of processes and the environmental conditions under which these sediments were deposited.

The granulometric analyses of sediments belonging to the Quaternary successions of Kim river valley reflects their poorly sorting, fine skewness and leptokurtic nature. The relatively low values of standard deviation and the positive numerical values of skewness indicate the transportation of these sediments by fluvial processes (Friedman and Johnson, 1982). As seen in the cumulative frequency size distribution curves, the sediments representing 40 – 50% by weight of the sample seems to have transported by rolling or sliding action and equivalent weight percentage of the sample by jumping motion, with a less than 5% transported by suspension. The C-M plot of these sediments strongly suggests the above observations. The bivariant plots (Moiola and Weiser, 1968; Stewart, 1958; Gleister and Nelson, 1974 and Sahu, 1964) obtained by using the various statistical parameters suggest that the sediments are mainly transported by riverine processes and represents fluvial environment of deposition.

The granulometric analyses for the sediments representing the Quaternary successions of lower Tapi river valley suggest to very poor sorting, near-symmetrical to fine-skewed and an overall mesokurtic nature. The poorly sorted nature and the positive values of skewness of these sediments reflect their formation by riverine processes (Friedman and Johnson, 1982). The cumulative frequency size distribution curves indicate that large part of these sediments have been transported by rolling, sliding and jumping motion and a very less proportion is transported by means of suspension, which is also reflected in the C-M plots. The bivariant plots, aptly suggests their transportation by means of fluvial processes and deposition in a fresh water fluvial conditions.

The granulometric analyses of sediments belonging to the Quaternary successions of Mindhola river valley reveal poorly sorting, near-symmetrical and mesokurtic nature.

The cumulative frequency size distribution curves indicate that majority of the sediments have been transported by rolling, sliding and jumping motion, whereas a very little proportion has been transported by means of suspension, which is also supported by the C-M plots of these sediments. The bivariant plots indicate that these sediments have been transported by riverine processes and deposited in a fluvial environment.

The X-ray diffraction studies of the representative samples of Quaternary sediments of the study area have pointed out the presence of the abundance of minerals such as quartz, plagioclase feldspar and calcite. In addition to these minerals, other minerals such as orthoclase, cristobalite, biotite, epidote, pyroxenes, olivine and goethite have been recorded in minor amounts. The clay minerals include smectite, illite, kaolinite and chlorite. The abundance of quartz in these sediments is attributed to the denudation and reworking of the Tertiary sediments and Deccan basalts. The occurrence of the plagioclase feldspars along with minor proportions of cristobalite, biotite, epidote, pyroxenes and olivine, indicates basaltic provenance. The presence of calcites within these sediments is dominantly on account of the calcium bearing rocks in the source area and partially contributed by the secondary infillings of calcium rich solution in the form of calcretes. The presence of mineral goethite indicates the Eh-pH conditions that are suggestive of non-marine waters (Picard and High, 1969).

According to earlier workers (Holmes and Hearn, 1942; Millot, 1953; Lafond, 1961; Packham et al., 1961; Biscaye, 1965 and Grim, 1968) the clay minerals reflects the parent material and the composition of the source rocks from which they have been derived. Millot (1970), Chamley (1989) and Kessarkar et al. (2003) have opined that the minerals such as smectite, illite and kaolinite are derived from the weathering of basic igneous rocks under humid tropical climate with intense rainfall. Accordingly, the presence of these minerals recorded in the present investigation reflects their source from the basic volcanics of Deccan Trap terrain. Interestingly, the high content of smectite is also observed in the sediments constituting the offshore (inner shelf) parts of Narmada – Tapi regions (Nair et al., 1982; Rao, 1990; Rao and Rao, 1995). According to Kumar and Singh (1978), the presence of smectite in the sediments indicates a good drainage system resulting in the deposition of these sediments. They are of the opinion that abundance of illite and presence of chlorite in soils and fluvial sediments indicate that neo-formation of clay minerals is not taking place, most probably due to high rates of sedimentation and inert nature of the environment. The presence of kaolinite in the sediments reflect low-salinity of the depositing medium (Couch, 1971) predominantly indicating the deposits of continental origin (Rateev, 1957). As suggested by Grim (1968), kaolinite normally disappears in marine sediments owing to the diagenetic transformation, however in case of riverine conditions, the leaching action favors the formation of degraded micas and kaolinite. According to Pryor and Glass (1961) kaolinite is dominantly seen in the sediments of fluvial environment.

The riverine nature of the sediments is well supported by the study of the surface textures of the quartz grains under scanning electron microscopy. The medium relief, sub-angular nature with low signs of abrasion on the surfaces of the quartz grains indicates that they have been subjected to less mechanical processes during erosion, transportation and deposition (Manker & Ponder, 1978). The commonly occurring surface features identified includes, conchoidal fractures, coalescing irregular impact pits, straight and arcuate steps, straight and curved scratches, friction features and mechanically formed "V" marks, which are clearly suggesting the influence of fluvial processes and energy conditions (Higgs, 1979; Manker & Ponder, 1978 and

Manickam & Barbaroux, 1987). Further Manker & Ponder (1978) are of the opinion that the presence of irregular pits points to a high energy conditions of the sub-aqueous medium. Krinsley & Funell (1965), have suggested that the presence of impact features indicate grain to grain and grain to substrate collisions whereas presence of different type of scratches are attributed to the movement of sharp edges against the grains during their transportation in a high energy aqueous medium. According to Higgs (1979), the presence of conchoidal fractures as well as straight and arcuate steps on the grain surfaces indicates short transportation and rapid deposition. He has further suggested that the "V" marks on the quartz grains are attributed to the impacts and represents their formation in sub-aqueous and aeolian environments under high energy conditions. Since less than 50% of the quartz grains so far studied exhibits the "V" marks on their surfaces, they clearly points to the fluviatile nature (Morgolis and Kennett, 1971).

The trace element analyses have provided interesting results that strongly favors the non-marine nature of the depositing medium. The significant absence of boron strongly suggests low salinity or non-marine waters (Keith and Degens, 1959). The pioneering works of Goldschimdt and Peters (1932) and Landergren (1945) have clearly indicated that the marine sediments contain more concentration of boron than do non-marine sediments. The presence of elements such as copper, nickel and chromium in traces also suggest the fresh water conditions of the depositing medium (Potter, Shimp and Witter, 1963). According to Mason (1960), the river water favors the precipitation of elements such as zinc, copper and bivalent iron. The presence of traces of manganese in the sediments of the study area also reflects fresh water environment of deposition (Friedman, 1969).

7.3 QUATERNARY STRATIGRAPHY OF LTRB

The composite profiles prepared for the continental Quaternary sedimentary successions (Fig. 7.6) exposed along the Kim, Tapi and Mindhola river valleys reflect cyclic sedimentation in the form of fining upward sequences. The composite profiles of Kim river valley shows three cycles of fining upward sequences, while in the case of Tapi and Mindhola river valleys, four distinct cycles are observed. The lateral correlation of the composite profiles of Quaternary successions belonging to these three river valleys reflect lithological similarities however, at places some of the lithological units are not represented in the vertical successions. Table 7.2 provides a detail account of the composite Quaternary stratigraphy of LTRB.

Chandra and Chaudhary (1969) have described the Quaternary deposition of mainland Gujarat as "Gujarat Alluvium". As far as the study area is concerned, the continental Quaternary deposits represent mappable unit with a wide lateral extension and vertical thickness. On the basis of the International Code of Stratigraphic Nomenclature (ISSC, 1970), these deposits have been assigned the litho-stratigraphic rank of a formation and have been formally designated as "Tapi Formation". This formation is further sub-divided into four different members based on the maximum number of lithological units and exposed thickness of the individual members. The formal nomenclature of each of these members corresponds to the geographic locations where they are exposed having maximum thickness. The systematic description of each of these members is given below.

(i) ***Dhatwa Member*** – This member is designated after the Dhatwa village, located in the downstream of Tapi river. This member represents the oldest of all members and is best exposed in the Tapi river valley. The lithological units of this member are found resting on the Deccan basaltic outcrops and comprises thin basal conglomerate followed by the gravelly unit with sandy matrix. The medium to fine grained sand and silt units follows subsequently. The topmost unit in this member is represented by clays. It is observed that this member is practically absent in the Kim river valley, however in the Mindhola river valley, it is represented by the upper clay units only.

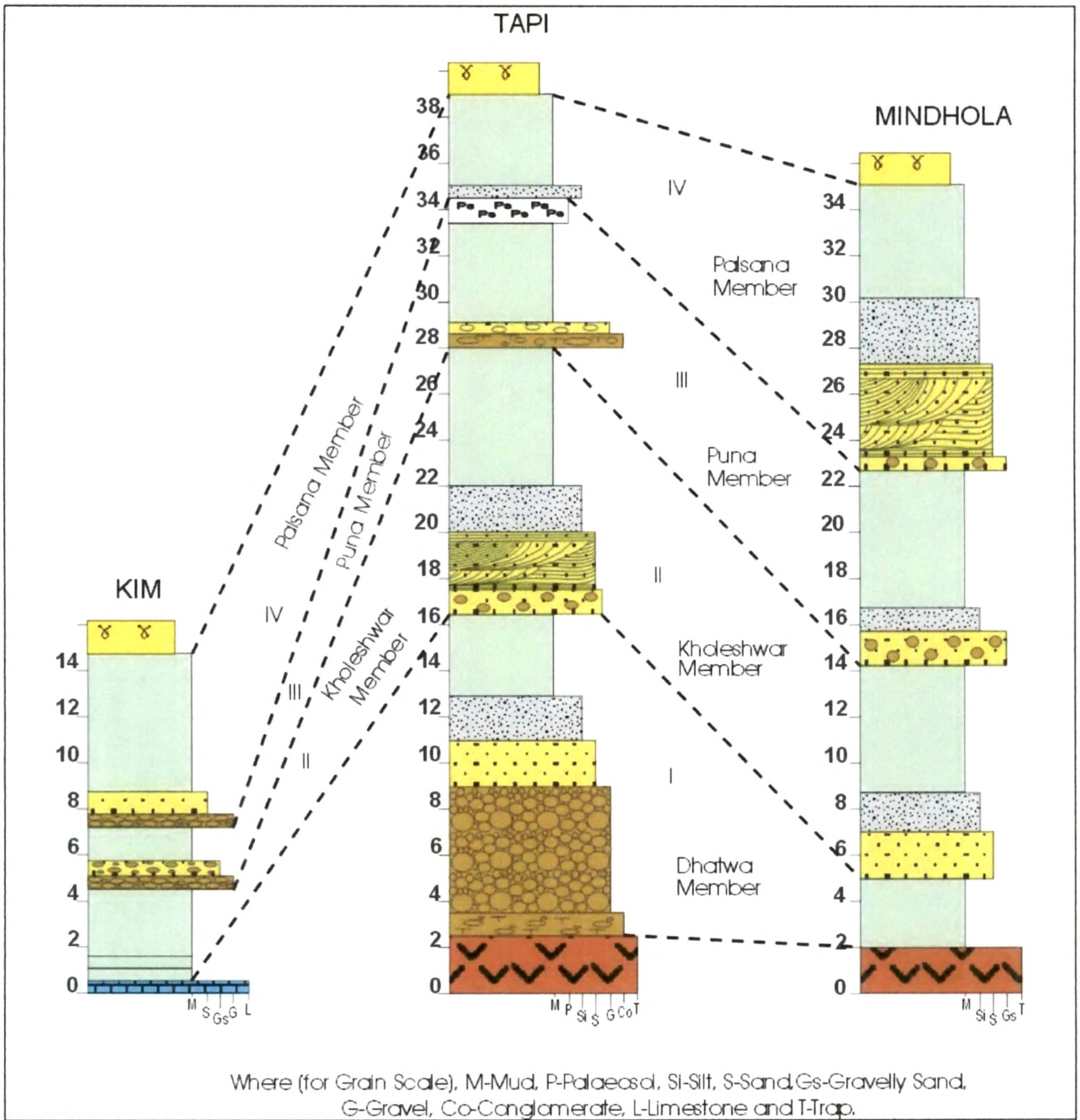


Fig. 7.6 – Figure Depicting The Composite Profiles Of Continental Quaternary Sediments Exposed Along Kim, Tapi And Mindhola River Valleys.

Age	*Formation*	*Member*	*Kim River Valley*	*Tapi River Valley*	*Mindhola River Valley*
Middle Pleistocene to Holocene	TAPI FORMATION	Palsana	Clays (6.5)	Clays (4.0)	Clays (5.0)
			-	Silts (0.5)	Silts (3.0)
			Sands (1.0)	-	Sands (4.0)
			Gravely Sands (0.5)	-	Gravely Sands (0.5)
		Puna	-	Palaeosol (1.0)	-
			Clays (1.0)	Clays (4.5)	Clays (6.0)
			-	-	Silts (1.0)
			Gravely Sands (0.75)	-	Gravely Sands (1.5)
			Gravels (0.5)	Gravels (0.5)	-
			-	Conglomerate (0.5)	-
		Kholeshwar	Clays (3.5)	Clays (6.0)	Clays (5.5)
			-	Silts (2.0)	Silts (1.5)
			-	Sands (2.5)	Sands (2.0)
			-	Gravely Sands (1.0)	-
		Dhatwa	-	Clays (3.5)	Clays (3.0)
			-	Silts (2.0)	-
			-	Sands (2.0)	-
			-	Gravels (5.5)	-
			-	Conglomerate (1.0)	-
------------------------ Unconformity --------------------------					
Middle to Upper Miocene	Kand	-	Limestone	-	-
------------------------ Unconformity --------------------------					
Upper Cretaceous to Eocene	Deccan Traps	-	Basalts	Basalts	Basalts

Table 7.2 – Composite Quaternary Litho-Stratigraphy Of Lower Tapi River Basin (Numerical Values Indicate Thickness In Meters).

(ii) ***Kholeshwar Member*** – This member is best exposed in the Tapi river valley and is named after the Kholeshwar village, in the downstream of this river. The lithological units comprise gravelly sands followed by medium to fine grained sands, silts and clays. The clay units, which represents the upper most horizon is found to have maximum thickness as compared to other units. In Kim river valley this member is represented by the upper most clay units, whereas in the Mindhola river valley, it is depicted by the presence of sand, silt and clay units, with the absence of the basal gravelly sands.

(iii) ***Puna Member*** – This member is also best exposed in the Tapi river valley and is designated after the Puna village, located in the downstream of this river. The lithological successions comprise a thin conglomerate bed followed by gravels, gravelly sands, silts and clays and a palaeosol (?) horizon, which represents the topmost unit of this member. In Tapi river valley, the gravelly sand and silt units do not show their presence, however, they are well represented in the Mindhola river valley and partly in the Kim river valley. The basal conglomerates and the palaeosol units are not delineated in either Mindhola or Kim river valleys.

(iv) ***Palsana Member*** – This member is best exposed in the Mindhola river valley and is named after the Palsana village, located in the downstream of Mindhola river. The lithological successions comprise gravelly sands followed by medium to fine sands and silts. The topmost unit in this member is represented by clays. In Tapi river valley, there is a marked absence of the lowermost gravelly sands and medium to fine sand units, whereas in Kim river valley, the silt unit is not well represented.

Based on the results discussed in the preceding pages of this chapter, it is clear that the continental Quaternary sedimentation history in the study area encompasses a complete record of sediments from middle Pleistocene to early Holocene period. These sediments have been deposited in a structurally controlled basin, having Tertiary Formations and Deccan Traps as sub-stratum. The studies carried out so far suggest that periodic reactivation along the basement fracture trends mainly the Narmada – Tapi (ENE – WSW) and Cambay (NNW – SSE) have controlled the sedimentation during Quaternary times in the study area. The interpretation and integration of data generated through field investigations and laboratory studies clearly points to the fact that the continental Quaternary sediments represent the deposition dominantly by fluvial processes. Although the middle Pleistocene period has been considered to be the time of overall transgression, however the study area seems to have been less influenced. This could be attributed to the active drainage network existing at that time, contributing a voluminous sediment input, thereby restricting the advancement of the sea further inland. During the late Pleistocene and early Holocene times, the study area and its environs experienced a regression phase, which is well reflected in terms of the palaeo-lobatic features. However, during the upper Holocene times, the sea seems to have ingressed further east in the study area, which is documented by the presence of raised mudflats at several locations.