CHAPTER 4

STRATIGRAPHY

The Quaternary sedimentation in the lower Narmada basin is facilitated by synsedimentary subsidence of the basin along the Narmada-Son fault (NSF) in a compressive stress regime (Chamyal et al. 2002). A huge thickness of Quaternary sediments (~800 m) is reported from the lower Narmada basin (Maurya et al. 1995). However, only the top 30-40 m of the total thickness of the sediments is exposed. This is attributed to the incision by the Narmada River in response to the basin inversion (uplift) during Holocene (Chamyal et al. 2002). Here an attempt has been made to reconstruct the physical stratigraphy of the exposed Quaternary sediments in the lower Narmada basin. Vertical lithologs of the exposed sections in the various geomorphic surfaces at several locations were prepared to reconstruct the physical stratigraphy (Fig. 4.1)

Late Pleistocene Stratigraphy (S_1 and S_2 surfaces)

The sediments that comprise S_1 and S_2 surfaces are exposed all along the lower Narmada valley in the form of 30 – 40 m incised cliffs. The exposed sediment succession starts with basal clays overlain by alluvial fan facies and alluvial plain facies. Two large alluvial fans have been mapped in the area and are termed as alluvial fan 1 and alluvial fan 2 by Chamyal et al. (2002). The alluvial fan 1 was previously described by Chamyal et al. (1997). The details on alluvial fan 2 were investigated during the course of this study (Chamyal et al. 2002). The exposed sediments were measured at several places along the S_1 and S_2 surfaces of the lower Narmada basin are described in the following pages.

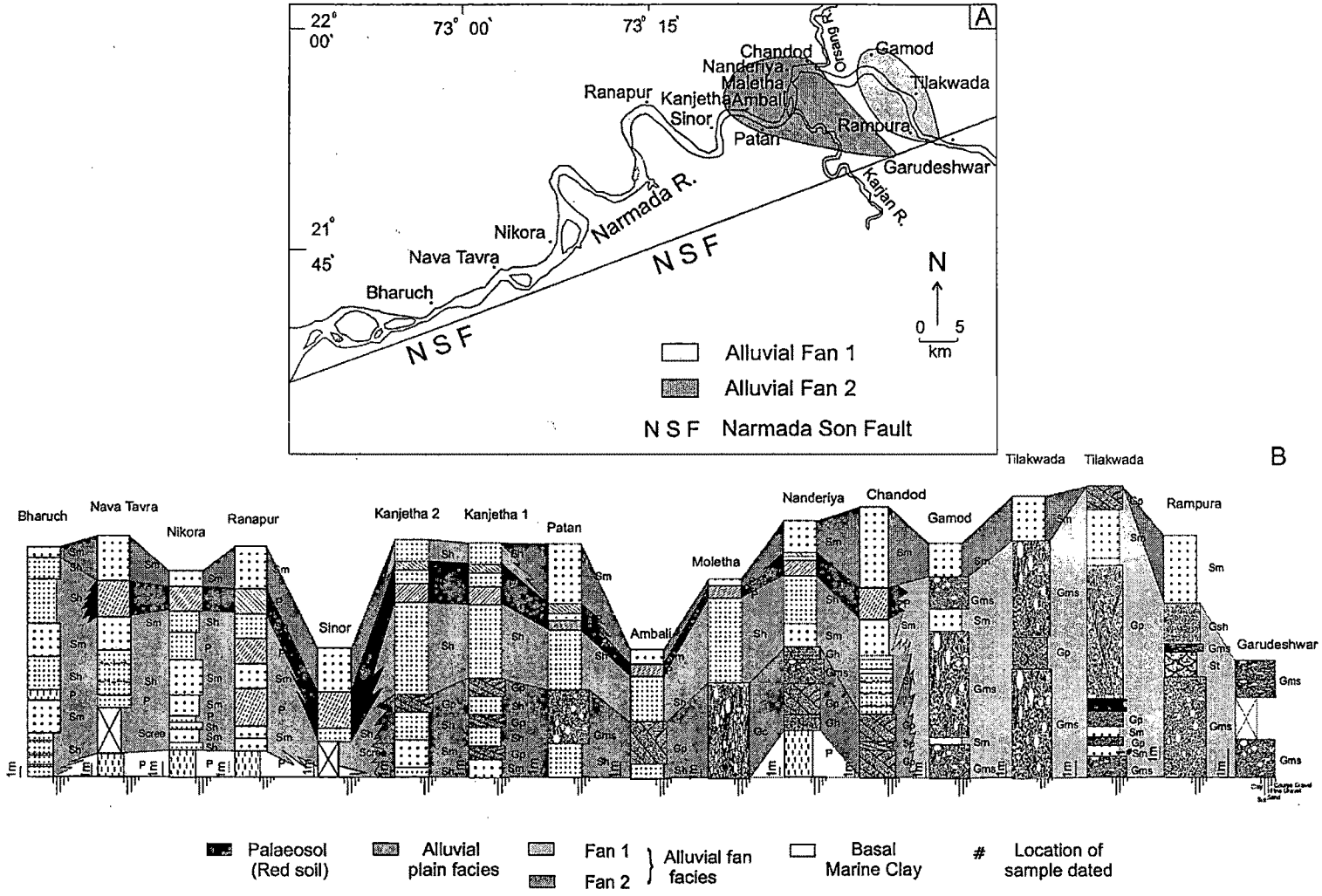

Fig .4.1. A. Map showing locations of the sites studied. B. Vertical lithologs of the exposed sediments along the Narmada River

Garudeshwar: The sediments exposed at Garudeshwar (Fig. 4.2) were described earlier by Chamyal et al. (1997) and belong to the alluvial fan 1. The exposed sediments are dominantly characterised by a thick matrix supported gravel deposit at the base which are of varying size. The gravels are basaltic in composition having a maximum clast size of 40cm.

Fig. 4.2. Photograph of proximal gravel facies of alluvial fan 1 at Garudeshwar

Rampura: This section has also been described earlier by Chamyal et al. (1997). Here the total exposed thickness of the alluvial fan 1 sediments is about 21 m (Fig. 4.3). At the base of the section occurs a matrix supported gravels (10 m) made up essentially of basaltic clasts which are sub-rounded to rounded in nature. The maximum clast size is about 55cm. A ~2m thick trough cross-stratified sand overlies the basal gravels which separates the two distinct units of the matrix supported gravels. The upper matrix supported gravel horizon is overlain by a horizon of stratified sandy gravel of 3m thickness. The pebbly to cobbly basaltic clasts have been found to represent various shapes like spheroidal, discoidal and cuboidal (Chamyal et al. 1997). The

Fig. 4.3. Photograph of gravelly sequence of Alluvial Fan 1 exposed at Rampura

alluvial fan sediments are overlain by massive sands (5m). These are sheets of sand showing no internal stratification.

Tilakwada: The sediments of alluvial fan 1 are best exposed at Tilakwada (Chamyal et al. 1997) (Fig. 4.4). The oldest exposed sediments at Tilakwada are made up of thick (2 m) matrix supported gravels. The gravels have a maximum size of 30 cm and are bounded together by sandy matrix. These are overlain by a lens of massive sand. This horizon was dated by Blue Green Stimulated Luminescence technique at PRL, Ahmedabad and is found to be <90ka in age. The sand is internally unstratified and is about 0.75 m thick. The massive sands are overlain by a planar cross-stratified gravel bed having a maximum thickness of about 5m.The planar cross-stratified gravels alternate with massive sand horizons and are at places as thick as 9 m.

Fig 4.4. Incised cliff section showing the sediment succession of alluvial fan 1 at Tilakwada

The alluvial fan 1 deposit (Fig. 4.5) occur all along the cliffy banks of Narmada around Tilakwada. At places basal matrix supported gravel is quite thick (6.5 m). The size of the clasts range from 25-35 cm and are dominantly basaltic. The top of the sediment succession at Tilakwada is represented by a massive sand of about 2.5 m thickness showing no internal stratification.

Fig. 4.5. View of right bank cliff at Tilakwada comprising sediments of alluvial fan 1

Gamod: The sediments exposed along the river Aswan a tributary of Narmada River comprise the distal fan facies of the alluvial fan 1 (Chamyal et al. 1997). The 14 m thick alluvial sediment succession at Gamod are dominantly a matrix supported gravels having a maximum size of 10 cm. Massive sands deposited on the top of the matrix supported gravel beds separates the couplets.

Chandod: The 40 m thick sediment succession exposed at Chandod has been considered as the basis for the reconstruction of physical stratigraphy (Bhandari et al. 2004). Fluvial deposits of 40 m thickness are exposed at Chandod (Fig 4.6). The base of the section is characterized by a 3 m thick planar cross stratified gravel (size ranging from 10-15 cm) and the matrix holding the gravels is of sandy origin. These are overlain by a 2 m thick planar cross stratified sand which is overlain by planar cross stratified gravels having a thickness of 4 m. Here the gravels are basaltic in origin and are supported by sandy matrix. Over this occur sediments of the alluvial plain facies. Above the planar cross stratified gravels 10 m thick horizontally stratified sand is deposited. This sand horizon is studded with rizoconcretions and horizontally stratified bedded calcretes. These are overlain by a 5 m of massive sand showing no internal stratification. The massive sand is overlain by pedogenised sand that is about 5 m thick. The soil has developed over fluvial overbank fine sands and silts and shows typical fracturing in the form of blocky aggregates. There is copious amount of calcretes throughout the horizon. The soil shows typical reddish brown colouration. Overlying this is 6 m thick deposits of massive sand which shows no internal stratification.

Fig. 4.6. Close view of the cliff section exposed at Chandod

Nanderiya: The sediment succession exposed along the right bank of Narmada River at Nanderiya comprises basal clays overlain by sediments of alluvial fan facies (Fan 2) and in turn by alluvial plain facies (Fig. 4.7). The basal clays are 6 m thick and are pedogenised. These show vertic characteristics and extensive fracturing giving rise to blocky aggregates, pseudoanticlines and hydroplastic slickenslides along the fractured surface (Fig. 4.8). The basal clay is overlain by alluvial fan sediments of alluvial fan 2. The basal clays are overlain by 2 m thick horizontally

stratified gravels which are pebbly in nature. They are overlain by planar cross stratified gravels having a thickness of 5 m. Matrix supported gravels of about 4 m thickness occur above the planar cross stratified gravels. The matrix supporting the gravels is sandy and the gravels are pebbly in nature. These alluvial fan sediments are overlain by sediments of alluvial plain facies. The alluvial plain sediments have a distinct boundary with the sediments of alluvial fan facies (Fig. 4.7). The alluvial plain facies is marked by a massive sand of 3 m thickness showing no internal stratification. These massive sands are overlain by horizontally stratified sands of 7m thickness. Over these lie the pedogenised sand of 4 m thickness. The pedogenised horizon is overlain by massive sand deposits of about 5 m thickness which show no internal stratification.

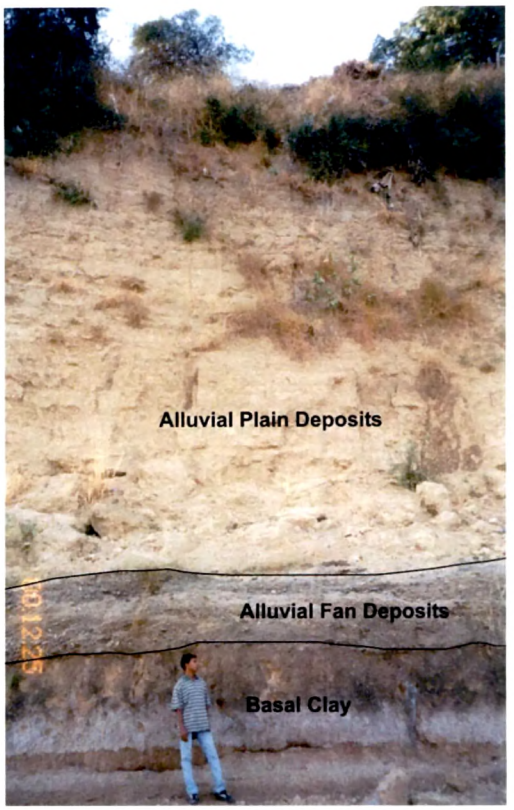

Fig. 4.7. Sediment succession at Nanderiya comprising basal clays overlain by alluvial fan facies and topped by alluvial plain facies

Maletha: At Maletha a 22 m sediment succession is exposed revealing alluvial fan deposits at the base overlain by alluvial plain deposits on the top (Fig. 4.9). At the base 10m of massive clast supported gravels are deposited. These clast supported gravels show a total absence of matrix and are tightly packed, unsorted and lack stratification and imbrication. The clast supported gravels are overlain by the horizontally stratified sand deposit having a thickness of 10 m

Fig. 4.8. Basal marine clays exposed at Nanderiya showing distinct vertic characteristics and extensive fracturing

with calcrete nodules in it. These are overlain by a pedogenised sand of about 1m which is reddish in colour. Massive sand of 1m marks the top of the sediment succession exposed at Maletha.

Fig. 4.9. Downstream view of the right bank cliff at Maletha showing the coarse fan facies overlain by finer alluvial plain facies

Ambali: Further downstream at Ambali a 10 m section is exposed comprising sediments of both alluvial fan as well as alluvial plain facies (Fig. 4.10). At the base 1m thick horizontally stratified sand is seen which is overlain by a planar cross stratified gravels of 3m. The gravels range in size from 10-15cm. These are overlain by sediments of alluvial plain environment. The alluvial plain sediments are characterized by 4 m thick horizontally stratified sand with calcrete nodules in it. This is overlain by pedogenised sand which is 1 m thick. Massive sands of about 1 m thickness with no internal stratification caps the sequence at Ambali.

Fig. 4.10. Photograph showing the upper part of the exposed Late Pleistocene sequence (loc. 1 km downstream of Ambali) 1. horizontally stratified overbank sands, 2. palaeosol, 3. thinly stratified sands and silts

Patan: This is one of the best exposed sections on the left bank of the lower Narmada basin. The total thickness of the section is about 35 m (Fig. 4.11). A horizontally stratified sand with calcretes occur at the base of the section which is about 5 m thick. The sands are overlain by a thick matrix supported gravel (7.5 m). The gravel clasts range in size from 10-15 cm and the matrix is coarse to fine sand. This gravelly horizon is actually a part of the alluvial fan 2 facies exposed on the left bank of the lower Narmada River. The finer sediments that rest over the matrix supported gravel are the deposits of alluvial plain facies. The horizontally stratified sand

Fig. 4.11. Sedimentary succession exposed at Patan revealing thick deposits of alluvial fan at the base overlain by sands and silts of alluvial plain environment on the top

(10 m), the pedogenised sand (4 m) with calcretes all throughout the horizon and the overlying massive sands (10 m) form the usual units of the alluvial plain facies.

Kanjetha: The total sediment thickness at Kanjetha is about 35 m (Fig. 4.12). At thebase occur massive sand (2 m) and planar cross-stratified gravels of the alluvial fan 2. The alternate succession of sands and gravels is 13 m thick. These are overlain by alluvial plain deposits. The alluvial plain facies here is represented by a thick (11 m) horizontally laminated

Fig. 4.12. Field photograph showing the lithosection exposed at Kanjetha

fine to medium grained sand. A pedoginised sand (4 m) have developed over the laminated sands which is red in colour. The top of the succession is marked by a horizontally stratified sand (4 m) which shows weak pedogenisis.

Sinor: Here a 10 m section made up of sediments of alluvial plain facies is exposed. The basal part of the section is covered by scree material (2.5 m). Over the scree material horizontally stratified sand (1 m) that shows parallel lamination is mapped. The sands are overlain by a 3 m thick pedogenised sand which is deep red in colour. The massive sands (3.5 m) form the top of the exposed sediment sequences at Sinor.

Ranapur: The section exposed at Ranapur (Fig. 4.13) is mainly made up of the deposits of the alluvial plain facies. A 2 m thick massive sand occurs at the base which is overlain by a 3 m thick pedogenised sand. The soil is reddish brown in colour and has abundant calcrete nodules. The pedogenised sands alternate with massive sand in this section. The sands are generally laminated. Massive sands of about 3 m thickness with no stratification occur on the top.

Fig. 4.13. Photograph showing stratified silts and sands of alluvial plain facies exposed at Ranapur

Nikora: The sediments exposed at Nikora (Fig. 4.14) starts with a 2 m thick basal marine clay which are highly pedogenised and show blocky aggregates, pseudoanticlines and slikenslides. Overlying the basal clays, horizontally stratified sand (3 m) showing parallel

Fig. 4.14. Field photograph of alluvial plain deposits exposed at Nikora. See the distinct pedogenised horizon overlying the massive sands

laminations are exposed. This is overlain by massive sand (1 m) which separates the upper horizontally stratified sand horizon from the lower one. Massive sands and horizontally stratified sands merging into the upper parts form the top of the sequence.

Nava Tavra: A 18 m thick section of the alluvial plain sediments is exposed along the right bank of the lower Narmada River at Nava Tavra (Fig. 4.15). A distinct bluish marine clay (2 m) is exposed at the base. This is overlain by a 4.5 m of horizontally stratified sand with profused calcretes occurring in the form of bedded calcretes. The sand shows parallel laminations. Massive sands of 2.5 m thickness showing pedogenesis occur over the stratified sands. The top of the sequence shows a 3.5 m thick horizontally stratified sands and silts.

Fig. 4.15. Photograph of Late Pleistocene deposits exposed at Nava Tavra revealing clay deposits at the base overlain by horizontally stratified sands

Bharuch: A sediment succession of 22m is exposed at Bharuch. At the base is the horizontally stratified sand of 5m thickness with bedded calcretes. This is overlain by 3m thick massive sand. Above the massive sand is 1 m of pedogenised clay which in turn is overlain by alternate horizons of massive sand (3.5 m) and horizontally stratified sand (7 m).

Early Holocene Stratigraphy (S_3 Surface)

The alluvial fan surface (S_3) occurs between the NW-SE trending fault passing through the river Narmada on its eastern side and by a NNW-SSE trending fault passing through the Karjan River, which is a tributary of the Narmada on its western side (Fig 4.16). The steep mountain front scarps trending ENE-WSW separating the Deccan Trappean highlands made up of basaltic lavas in the south from the alluvial fan surface is a morphological expression of the deep-seated Narmada Son Fault (NSF) (Biswas, 1987). This fault provided favourable physiographic setting for the formation of alluvial fans around Rajpipla. The rocks constituting the upland comprise basaltic flows with andesite, trachyte and picrite (Merh, 1995). Towards the north, the alluvial fan surface forms the central part of the area. The alluvial plain occupies the northern and northwestern parts of the area.

The streams arising in the upland flow down over the NSF and form an apron of coalescing fans. The alluvial fan deposits cover an area of 58 km^2. The altitude of the fan surface near the mountain front is 120 m. There are five fans reported in the area. Fan-4 is the biggest in size having an axial length of 7 km, but decreasing towards east to about 3 km in Fan-1(Fig. 4.17 A). Fan-3 was studied in detail for geomorphological features. The drainage basin of Fan-3 (Fig. 4.17 B) constitutes an area of 4.75 km^2 and the fan area covers 13.62 km^2. Ordering of the streams of the drainage basin of Fan 3 was done following Horton (1945). The feeder channel is of the fourth order and has carved out an embayment at the apex of the fan. The incised channel is

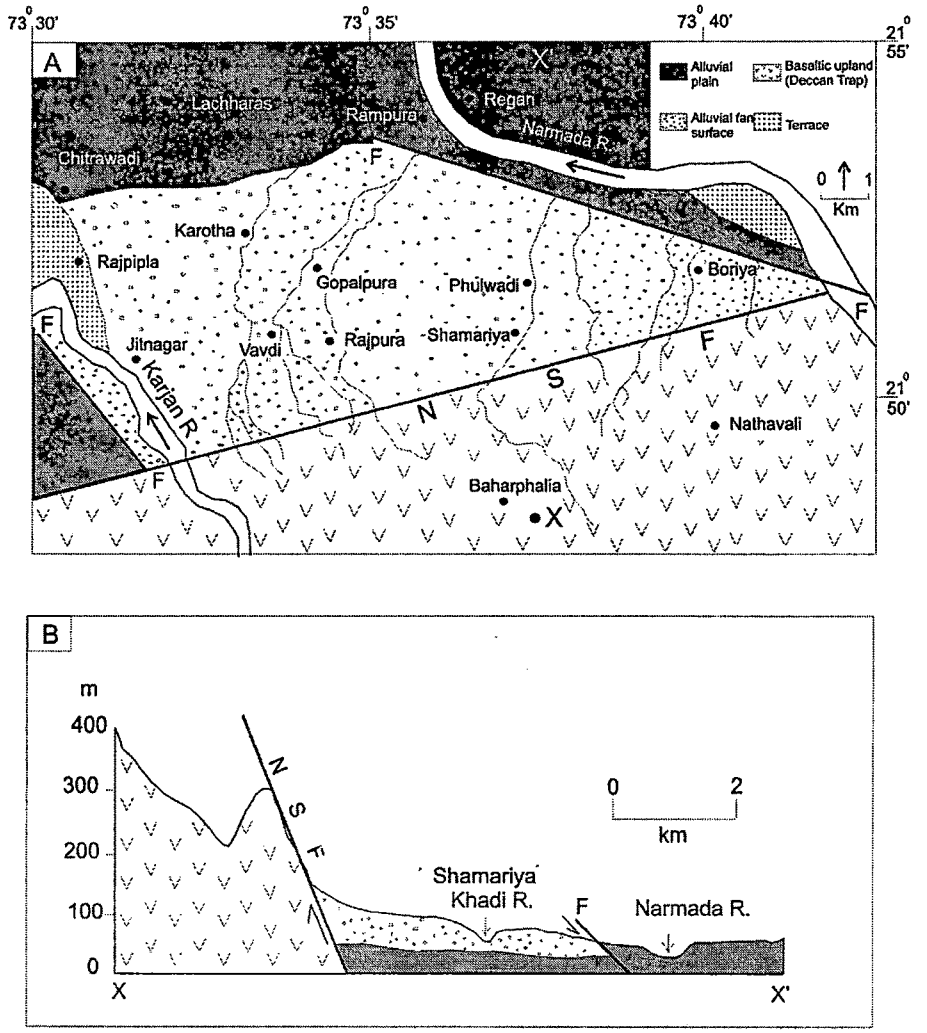

Fig. 4.16. A. Geomorphological map of the S_3 surface (after Bhandari et al. 2001). B. N-S cross section along X-X` showing the inter-relationship between the various geomorphic surfaces around Rajpipla. Legend is same as in A

a downslope extension of the feeder channel on the fan. It has typical fan morphology with

contour lines bulging down-fan. The longitudinal and cross sections of the fan area show a convex-up and plano-convex geometry (Fig. 4.17 B). The various lithologs (Fig. 4.18) exposed and studied for the purpose of the reconstruction of stratigraphy of this surface are described as under:

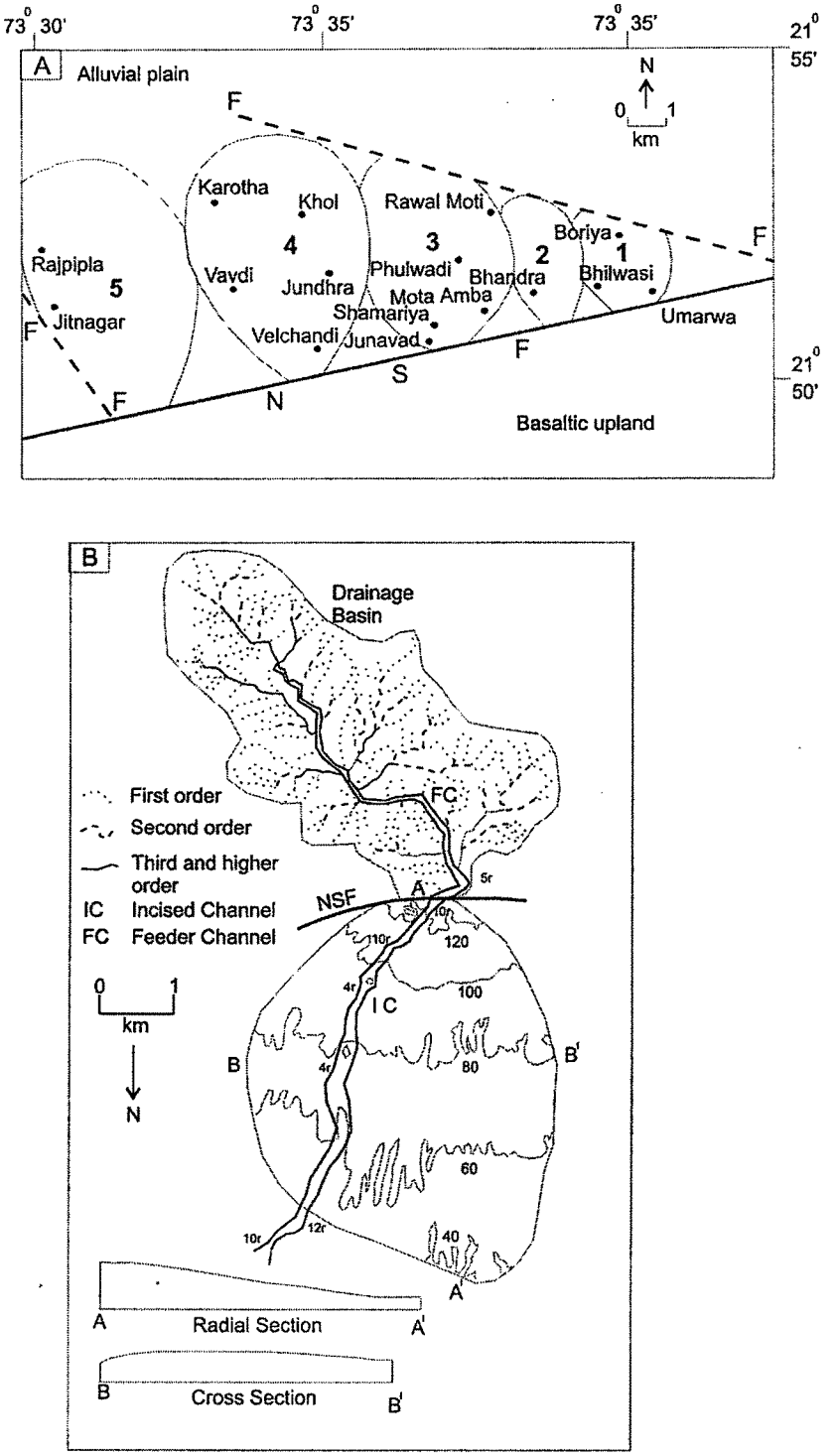

Fig. 4.17. A. Alluvial fans along the Narmada-Son Fault (NSF). Fans are numbered 1 to 5. B. Map showing detailed geomorphic characteristics of Fan3

Umarwa: A 3 m section exposed at Umarwa depicts deposits of the proximal facies of Fan 1 (Fig. 4.17 A, 4.18). At the base of the section matrix supported gravels are exposed having a thickness of about 1.5 m. The gravels are of basalts with a matrix of coarse sand and the maximum clast size is ~50 cm. The clasts are angular to sub-angular in shape. The matrix supported gravels are overlain by planar cross stratified gravels of 0.5 m thickness. This is overlain by clast supported gravels on the top (1m). The clasts are angular in shape with a maximum size of ~50 cm.

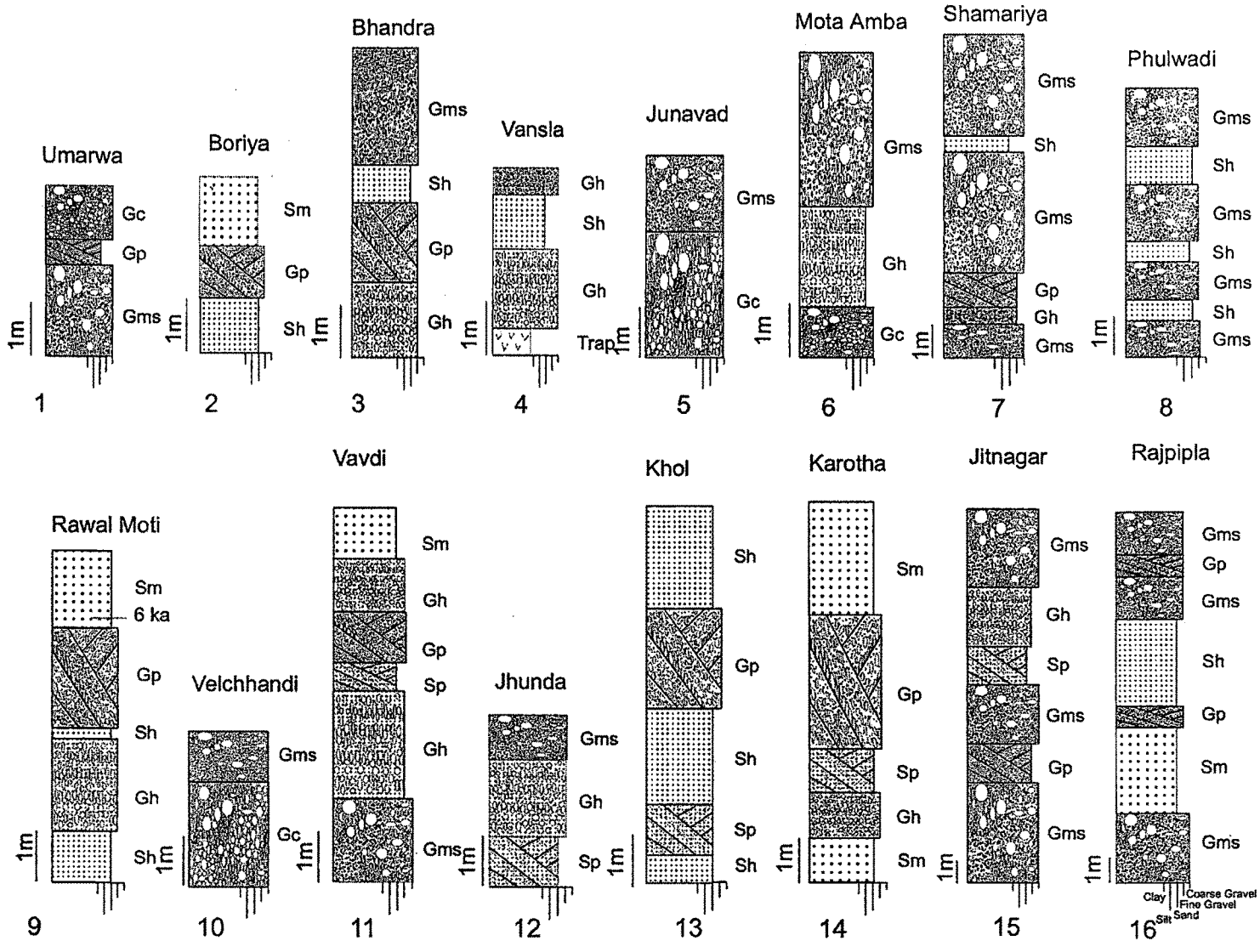

Fig. 4. 18. Lithologs and lthofacioes assemblages of the sections measured in alluvial fans. Locations are shown in Fig. 4.17

Boriya: This section comprises sediments of the distal facies of Fan 1. Horizontally stratified sands (1 m) occur at the base. These are overlain by planar cross stratified gravels (1 m), ranging in size from 5-20 cm. These gravels are overlain by a massive sand (1 m).

Bhandra: This is a 6 m section (Fig. 4.19) representing sediments of the medial fan facies of Fan 2. At the base occurs a 1.5 m thick horizontally stratified gravel, ranging in size from 10-25 cm. These are overlain by planar cross stratified gravels (1.5 m) having a maximum size of 20 cm and are angular to sub-angular. The horizontally stratified sand (1 m) rests over the gravels. The top of the section shows matrix supported gravels (2 m) comprising sub-angular fragments of basalts ranging in size from 10-50 cm.

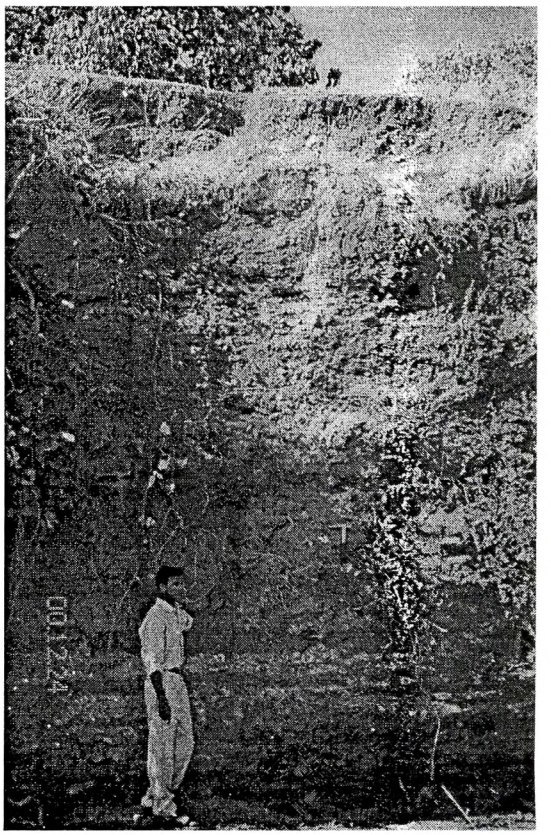

Fig. 4.19. Field photograph of fan sediments exposed at Bhandra

Vansla: At Vansla deposits of distal facies of alluvial Fan 2 are deposited. Here even the basement rocks are entrenched (1.5 m) over which the sediments of Fan 2 are deposited. The horizontally stratified gravel (1.5 m) overlie the trappean rocks and the maximum clast size is 10 cm. Above the gravel occur horizontally stratified sands of about 1.5 m thick, which are overlain by yet another bed of horizontally stratified gravels (1 m). The clasts are well-rounded and the matrix is of fine sand.

Junavad: The 3 m section exposed at Junavad shows the proximal deposits of Fan 3 (Fig. 4.20). The section exposed is at the base of mountain front (NSF). At the base clast supported gravels (2 m) are

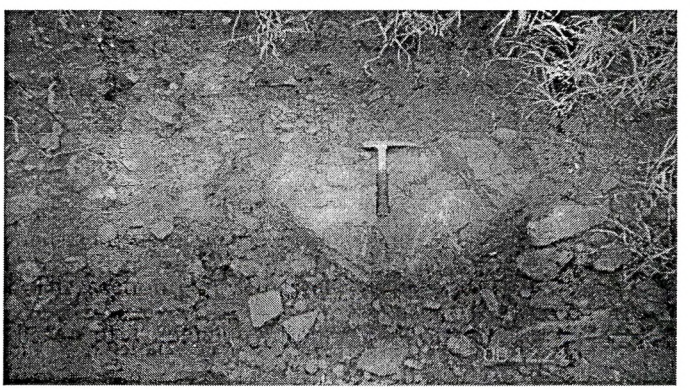

Fig. 4.20. Close up of clast supported gravels exposed at Junawad

exposed. The gravels range in size from 50-100 cm and are angular to sub-angular in shape. These are overlain by matrix supported gravel (1m), the matrix is gritty sand and the gravels are angular to sub-angular and are of trappean origin.

Mota Amba: The sediments exposed at Mota Amba are again the proximal fan deposits of Fan 3. The 6 m section shows clast supported gravels (1m) at the base, the clasts are angular to sub-angular with a maximum clast size of 100 cm. These are overlain by horizontally stratified gravels and in turn are overlain by matrix supported gravels.

Fig. 4.21. Field photograph of Shamariya section (9m) exposing medial fan deposits

Shamariya: Along the banks of Shamariya Khadi near Shamariya 9 m of fan sequence is exposed (Fig. 4.21). The sediment characteristics are typical of the medial fan facies of Fan 3. At the base occurs a matrix supported gravel (1 m) which is overlain by 0.5m of horizontally stratified gravels. These are overlain by planar cross stratified gravels (1 m). A horizontally stratified sand (0.5 m) overlies the gravels. On the top of the sequence a 3 m of matrix supported gravel is seen. The gravels are sub-angular to sub-rounded in shape and range in size from 30-50 cm and are of trappean origin.

Phulwadi: A good mid fan succession of Fan 3 is exposed at Phulwadi (Fig. 4.22) on the banks of Shamariya Khadi. The sequence

Fig. 4.22. Photograph of medial fan deposits at Phulwadi showing distinct layers of matrix supported gravels and horizontally stratified sand. (height of the person is 1.75 m)

starts with a matrix supported gravel (1 m), overlain by 0.5 m of horizontally stratified coarse sand showing weak parallel laminations. Over this occurs a matrix supported gravel (1 m) having coarse sand as its matrix. These are again overlain by 0.5m horizontally stratified sand and horizontally stratified gravels. On the top of the sequence occurs a matrix supported gravel (1 m), the clasts are of trappean origin, sub-angular to sub-rounded in shape having a maximum size of 15 cm.

Rawal Moti: Here, the distal fan facies sediments are exposed (Fig. 4.23). At the base occur a horizontally stratified sand (1 m) which is medium to coarse grained. This is overlain by horizontally stratified gravels (2 m), the gravels are rounded in shape and are very fine. The gravel are overlain by horizontally stratified sand (0.5 m), which in turn merge upward into a planar cross stratified gravel having a thickness of about 2 m. The gravels are well rounded and have a maximum size of 5 cm supported by medium sand. These are overlain by massive sands (1.5 m). The only sample of this horizon dated at Physical Research Laboratory (PRL), Ahmedabad by BGSL technique revealed an age of 6 ka indicating its early Holocene age.

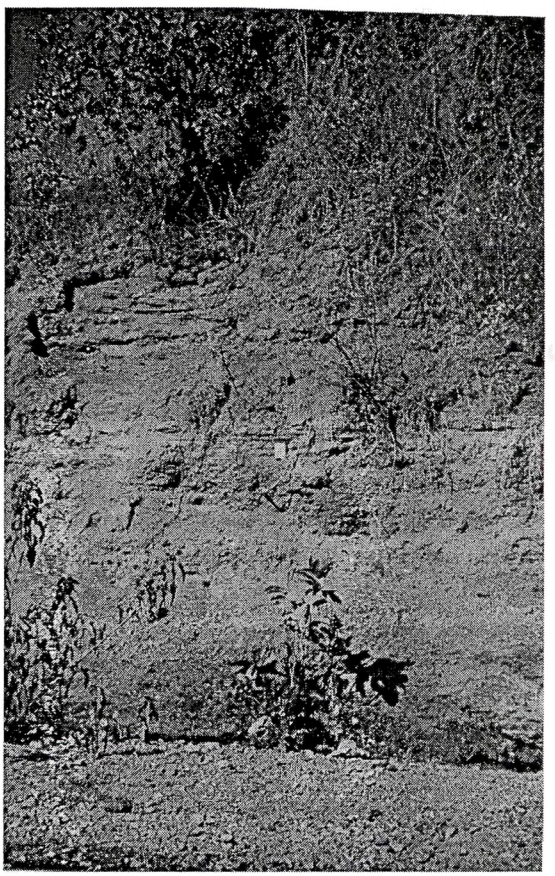

Fig. 4.23. Photograph of Distal fan deposits exposed at Rawal Moti

Velchhandi: A 3m sequence representing proximal fan facies of Fan 4 occur at Velchhandi. A 2 m thick clast supported gravel which are angular to sub-angular in nature occurs at the base. These are overlain by matrix supported gravel of about 1 m. The gravels are angular to sub-angular with a maximum clast size of 100 cm.

Junda: The 3.5 m section exposed at Junda comprises sediments of proximal fan environment. At the base 1m of planar cross-stratified sand is overlain by 1.5m of horizontally stratified gravels. The gravels are angular to sub-angular in nature. On the top matrix supported gravels are deposited having a thickness of 1m.

Vavdi: The sediments at Vavdi are that of medial fan environment. 1.5m matrix supported gravel is exposed at the base. The gravels are sub-angular to sub-rounded in nature. These are overlain by 3 m of horizontally stratified gravels. The gravels have a maximum size of 15 cm. Over these

lie 0.5 m of planar cross stratified sand. The sand is medium to coarse in nature. The planar cross stratified sand is overlain by 1 m of planar cross stratified gravels. These are overlain by horizontally stratified gravels (1 m). The section is capped by a massive sand (1 m).

Khol: At Khol deposits of distal fan facies of Fan 4 are exposed. The total thickness of the section is 6 m, the base is marked by a horizontally stratified sand (0.5 m). Overlain by a planar cross stratified sand (1 m) which in turn is overlain by planar cross stratified gravels (2.5 m). The gravels are of trappean origin sub-rounded to rounded in shape and have maximum size of about 10 cm. These are covered by horizontally stratified sand (2.5 m).

Karotha: This is also a section logged in the distal end which reveals 1 m of massive sand at the bottom, overlain by horizontally stratified gravels (1 m), overlain by 1 m thick planar cross stratified gravels (Fig. 4.24). The gravels belong to trappean rocks and are well rounded and have a maximum size of 5cm. A massive sand having a total thickness of 3 m caps the section.

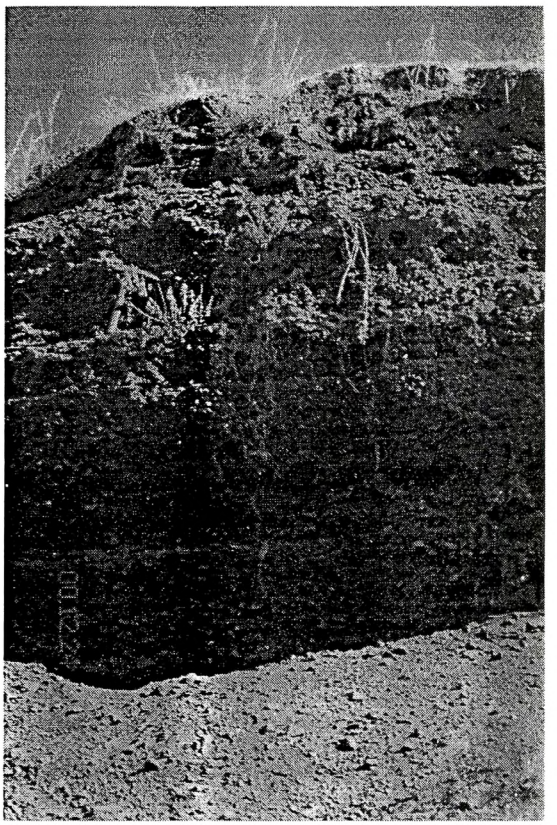

Fig. 4.24. Field photograph of distal fan deposits exposed at Karotha. Note the finer nature of the sediments and the gravels deposited are well rounded

Jitnagar: The section exposed at Jitnagar represent sediments of Fan 5. The 18 m section exposes sediments of medial fan environment. The base is characterized by a matrix supported gravel (5 m), which are sub-angular to sub-rounded and are of trappean rocks. These are overlain by planar cross stratified gravels (2 m), and in turn by a matrix supported gravel (3 m). The planar cross stratified sand (2 m) overlie the matrix supported gravels. The gravels range in size from 10-15 cm. Matrix supported gravel of 3 m are exposed on the top. These have a maximum size of 10 cm and are sub-rounded to sub-angular in shape and are supported by sandy matrix.

Rajpipla: The 21 m exposed section at Rajpipla (Fig. 4.25) reveals the medial fan deposits of Fan 5 which overlie the Late Pleistocene sediments with an erosional contact. At the base 3.5 m of matrix supported gravels are exposed. The maximum clast size is 15 cm having sub-angular to sub-rounded shape. These gravels are supported by a coarse sandy matrix. Overlying this is

massive sand deposit of 5 m. Abundant calcrete nodules occur within the massive sands. The sand is overlain by planar cross stratified gravel (1 m) over which horizontally laminated sand of 5 m is deposited. The calcretes are deposited along the bedding planes. These are overlain by 3 m of matrix supported gravel. The gravels are sub-rounded to sub-angular in nature supported by sandy matrix. Overlying this is planar cross stratified gravel (1 m). The gravels are sub-angular to sub-rounded having a maximum size of 10 cm and are supported by sandy matrix. The top of the section is marked by matrix supported gravels (3 m) of Fan 5. The gravels are pebbly to cobbly in nature and are supported by sandy matrix.

Fig. 4.25. Field photograph of Rajpipla section showing Late Pleistocene sediments capped by Early Holocene Fan deposits

Mid-Late Holocene Stratigraphy (S_4 Surface)

The S_4 surface is a wide flat topped terrace surface of 5-6 m height, which occupy a deeply incised fluvial valley comprising Late Pleistocene sediments. Tidal estuarine sediments are found in the lower reaches of the Narmada basin and fluvial sediments in the upper reaches. Similar terraces are reported from the adjacent Mahi and Sabarmati River valleys (Maurya et al. 2000). No evidence of ravine erosion is seen in these terraces and they abut against the abandoned cliffs comprising of Late Pleistocene sediments (Chamyal et al. 2002). These palaeobanks allow for a fairly accurate determination of the morphology of the incised fluvial valley and the estuary in which the valley fill terraces were deposited. Since the base of the palaeo-valley is not exposed, the incised cliffs of the terraces reveal only a part of sediments comprising the valley fill terraces. The various lithologs prepared along S_4 surface are shown in Fig. 4.26 and described below.

SuklaTirtha: At SuklaTirtha 1.15 m of Holocene estuarine sediments are exposed. Horizontally stratified sand occurs at the base having a thickness of 0.20m. Overlying this 0.25m of clay is deposited. Over which 0.20m of horizontally stratified sand occurs. This is overlaid by a thin

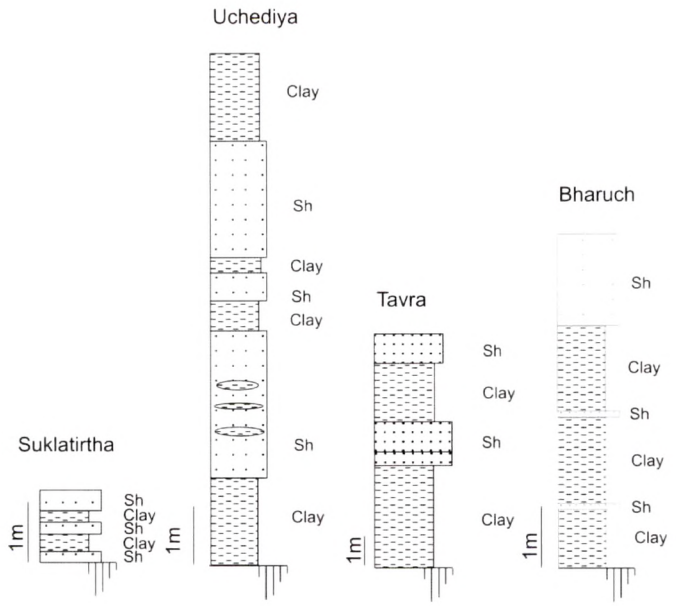

Fig. 4.26. Lithologs of S_4 surface exposed in the lower Narmada basin

layer of clay (0.15 m). The clay is dark in colour and organic rich which is topped by horizontally stratified sand (0.35 m). The sand is fine to medium grained.

Ucchediya: The Ucchediya section (Fig. 4.27) exposed at the mouth of Madhumati River exposes the Holocene estuarine deposit. The 8.5m section exposes 1.25m of organic clay

Fig. 4.27. Field photograph of Holocene estuarine section at Uchediya (8.5 m) exposing alternate layers of organic clays and sands

at the bottom. The clay is dark brown in colour and vertic in nature. This is overlain by fine to medium grained horizontally stratified sand having a thickness of 2.5m. Lenses of clay occur in between this horizontally stratified sand. This is overlain by 0.5 m of clay, which is dark in colour because of organic contents in it. Over this 0.5 m of horizontally stratified sand is deposited showing parallel laminations. A 0.25 m thick clay deposits overlain by 2m of horizontally stratified sand and a clay (1.5 m) occur in the order of superposition and provide an opportunity to prepare the stratigraphy of the valley fill terraces in the lower Narmada basin.

Tavra: The 6m section exposed at Tavra (Fig. 4.28) along the banks of Narmada River exposes the Holocene sediments of estuarine environment. At the base 0.5m of clay is exposed which is dark in colour and is organic rich. This is overlain by 4 cm of sandy layer occurring in the form of a lens, over which a silty clay (1.2 m) is exposed. The top is marked by a 3.5 m of organic rich clay deposit.

Fig. 4.28. Field photograph of Holocene section exposed at Tavra (6 m). thick clay deposits with thin bands of intervening sand layers are exposed

Bharuch: A 8 m Holocene section at Bharuch (Fig 4.29) is exposed comprising a thick clay at the base. This is overlain by 15 cm thin lens of sandy silt which alternates with, dark coloured organic rich laminated clay (20 cm). A 1.2 cm of dark organic rich laminated clay, dark brown to blackish in colour overlies the thin alternate

Fig. 4.29. Holocene estuarine terrace section exposed at Bharuch

layers of silt and clays. This is overlain by silty sand (1.25 m) and the top (45 cm) is marked by a sandy soil.

Stratigraphy

Detailed lithostratigraphic studies on the exposed sections of the Late Pleistocene sediments in the lower Narmada basin have revealed a basal marine pedogenised clay of 1-2 m thickness (Fig. 4.30). This clay was apparently deposited during the last interglacial high sea level (~125 ka). These deposits occur at the base showing vertisolic characters and are readily identifiable owing to its laterally consistent occurrence and extensive fracturing. The pedogenised clay is overlain by vertically stacked fluvial sediments now exposed in the imposing 30-50 m high incised cliffs all along the Narmada River. These sediments have been classified into two major lithofacies – the alluvial fan facies and the alluvial plain facies. The alluvial fan facies comprises two large alluvial fans – fan 1 and 2 (Chamyal et al. 1997, 2002). Both the fans occupy similar stratigraphic position and are correlatable. The alluvial plain facies stratigraphically overlie the alluvial fan sediments. These are dominated by overbank sediments and comprise fine sand and silts. On the top of the alluvial plain sediment succession thick reddish brown palaeosols occur. Pedogenic calcrete nodules of this palaeosol in the lower Narmada basin have been dated to ~24,000 years B.P. (Allchin et al. 1978), which marks the period of pedogenic transformation of the overbank fines. The palaeosol is again overlain by stratified fluvial sands and silts. The aeolian sediments which blanket the fluvial sediments in the adjacent Mahi and Sabarmati basins are not well represented in the Narmada basin, though they do occur as capping over the fluvial sediments in the Orsang valley, a tributary of lower Narmada. These sediments are attributed to the extreme arid climate during Late Pleistocene which peaked around 18 ka (Yan and Petit-Maire, 1994) resulting in the

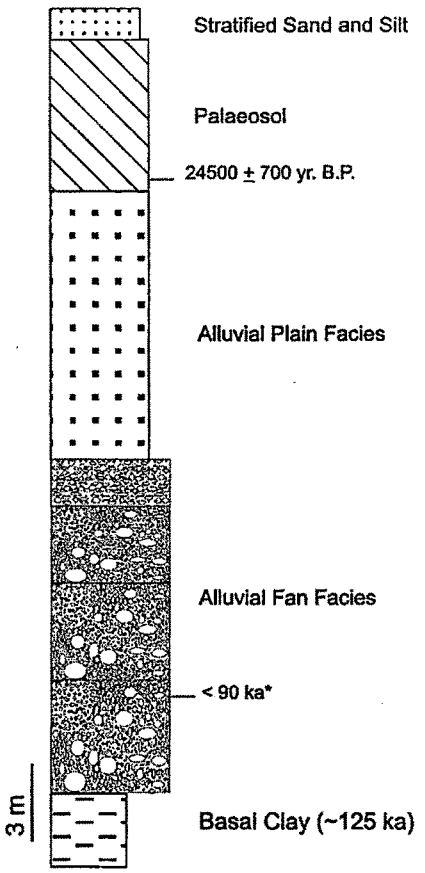

Fig. 4.30. Composite lithostratigraphic profile of the exposed Late Pleistocene sediments in the lower Narmada basin (after Bhandari et al. 2004)

extension of Thar desert into Gujarat alluvial plains (Allchin et al. 1978) which at present is restricted to the NW of Gujarat state. Blue Green Stimulated Luminescence (BGSL) dating of one sample from the middle part of the alluvial fan 1 sediments exposed at Tilakwada (sample no. NT- 1) have yielded an age of <90 ka (Chamyal et al. 2002). The age of Fan 1 confirms with the stratigraphic framework for the sediments of S_1 and S_2 surfaces. This together with the basal marine clays deposited during the last interglacial high sea (~125 ka) suggest that the sediments of S_1 and S_2 surfaces in the lower Narmada basin are of Late Pleistocene age.

The age of top of the sediment succession of S_3 surface which overlie the Late Pleistocene sediments indicates that the deposition of these sediments terminated around 6 ka (BGSL date of sediments at Rawal Moti - Fig. 4.18). The S_4 surface in the lower Narmada basin are comparable to those reported from lower Mahi valley which are found to represent the aggradation phase of Mid-Late Holocene which lasted from 6400 $\pm$ 120 yr B. P. to 1760 $\pm$ 80 yr B. P. (Kusumgar et al. 1998; Maurya et al. 2000). This suggests that the sediments of S_4 surface in the lower Narmada basin are of Mid-Late Holocene age and are related to the Middle Holocene transgression observed regionally and globally (Hashimi et al. 1995; Chappell and Shackleton, 1986).