CHAPTER - III

GEOLOGICAL SETTING

REGIONAL GEOLOGY

In order to get a clear picture of geology of the Himatnagar area in the regional set up, the author has presented a broad review of geology of Gujarat. Geomorphologically Gujarat state can be divided into three units viz. (i) Mainland Gujarat (ii) Saurashtra and (iii) Kutch. These three units show fairly diverse geomorphology and geology. The Mainland Gujarat consists of rock type ranging in age from Pre-Cambrian to sub-Recent while the Saurashtra and Kutch regions contain the rocks of Mesozoic and Cenozoic Eras only (Fig. III.1). The salient features of these units are as follows :

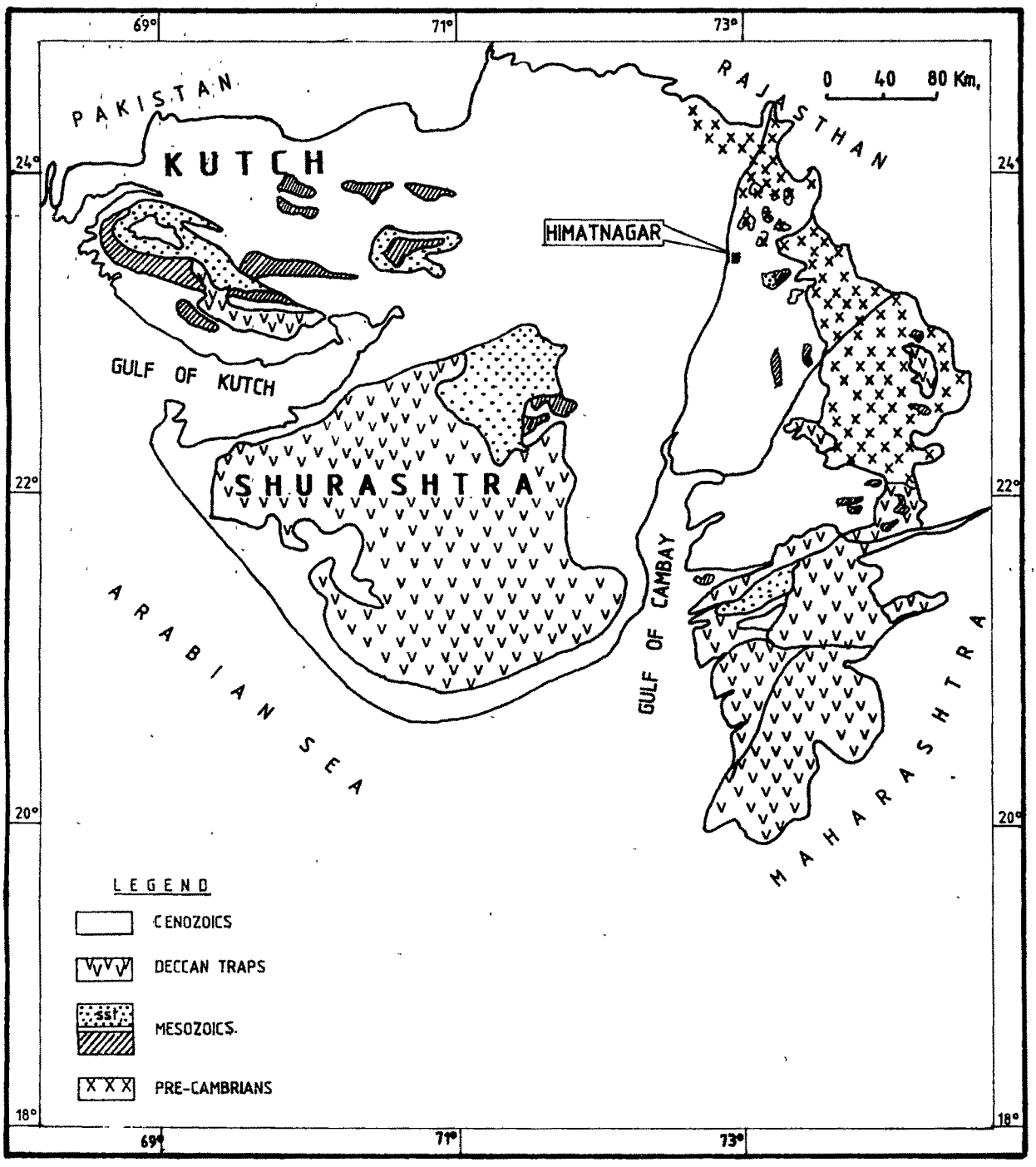


FIG. III. 1 GEOLOGICAL MAP OF GUJARAT

a) **Mainland Gujarat**

This unit forms mostly an alluvial basin and is bounded by estuarine tracts of Tapi and Narmada in the south. It extends for about 400 km northwards merging into the desertic plains of Rajasthan and Rann of Kutch. The eastern border is bounded by Aravalli, Vindhyan, Satpura and Sahyadri hill ranges.

The southern part bordering the alluvial tract, mostly forms a typical Deccan trap topography. The drainage is mainly south westerly or westerly evidenced by the flow of rivers like Tapi, Narmada, Mahi, Sabarmati etc. Geologically the rocks of the Mainland Gujarat comprise the Pre-Cambrian metasedimentaries & igneous rocks, Mesozoics (Baghs, Himatnagar Sandstones, Lametas etc.), Deccan Traps, Tertiaries, Recent and sub-Recent rocks.

b) **SAURASHTRA**

This unit is bounded by Gaj plains in the W and NW, Gulf of Kutch & Little Ranns to the N, Gulf of Cambay to S and Arabian sea to SW. The central part of the region forms an elevated trappean table land from where most of the rivers originate and flow radially. The terrain generally slopes gently towards the coast in the N,S,W and SE. The major rocks of this unit are mainly Mesozoics (Dhrangadhra and Wadhwan Sandstones), Deccan Traps, Tertiaries, Quaternaries including Recent and sub-Recent sediments.

c) **KUTCH**

The Kutch Mainland is isolated by the Great Rann to the N and E, Little Rann to the SE, Gulf of Kutch to the S and Arabian sea in the W. The central part forms a table land sloping on all sides. There are several E-W trending hills. North flowing rivers disappear in the Ranns, others join the sea. The Banni (the made up land) is formed by sediments deposited by the north flowing rivers in a strip along the northern borders of the Mainland and is composed of silty soil. The Rann is saline desert for the greater part of the year and remains marshy during the monsoon when a vast sheet of waters from the sea inundates. The Ranns are divided into Great Rann and Little Rann which do not differ from each other except in size. When dry, the surface is covered by thin layers of salt and shingles above a thick sticky fine clay and silt horizon.

Geologically this unit comprises the Mesozoics-including Deccan Traps, Tertiaries and Quaternaries. A generalised stratigraphy of the various rock units of Gujarat is given in Table III.1.

STUDY AREA

The igneous, metamorphic and sedimentary rocks belonging to Pre-Cambrian and Mesozoic Era occur in the neighbourhood of Himatnagar. The western and southern part of the study area is concealed under the Recent alluvium whereas good exposures of

TABLE III.1 GENERALISED STRATIGRAPHY OF GUJARAT

GEOCHRONOLOGICAL UNIT (PERIOD)	DURATION IN M.Y.	AGE IN M.Y.	MAINLAND GUJARAT	SAURASHTRA	KUTCH
1	2	3	4	5	6
Recent & sub-Recent	-	-	Alluvium	Alluvium	Alluvium and coastal plains
Pleistocene & Holocene	2	2	Carbonate dunes etc.	Porbandar Fm	Miliolities (Inland)
Pliocene	3	5	-	Dwarka Fm	Kankavati series
Miocene	21	26	Jhagadia Fm. Tarkeshwar Fm.	Gaj Fm	Khari Series
Oligocene	12	38	-	-	Barmoti Series
Eocene	16	54	Vaghadkhol Fm.		Barwali Series
Paleocene	11	65+2	Laterites Deccan trap	Laterites Deccan trap	Deccan trap
Cretaceous	65	130+5	Intra trappeans/ Lamatas/Bagh (Nimar sst.)/ Himatnagar sst.	Wadhwan Fm. Dhrangadhra Formation	Bhuj Fm.
Jurassic	50	180+5			Juran Fm. Jumra Fm Jurio Fm
Triassic	50	230+5			
Permian	40	270+5			
Carboniferrous	80	350+10			
Devonian	50	400+10			
Silurian	40	440+10			
Ordovician	60	500+15			
Cambrian	100	600+20			
Proterozoic			Erinpura Granites Delhi System Aravalli System		
Archaean			Banded gneissic Complex		

older rocks are seen in the NW, N, NE, E and SE of Himatnagar (Fig. III.2). The exposures are encountered in the elevated hills, in the lowlying areas and riverbeds. The dominant exposures are of Himatnagar sandstones with conglomerates, siltstones, clay or shales alongwith Erinpura granites, Delhi/Aravalli quartzites and mica-schists. Depending upon the predominance of their occurrence in the low lying areas, river beds and the elevated hills, these exposures are grouped and described in the following three units (Table III.2).

a) Around Himatnagar (Lowlying exposures predominant)

b) NW of Himatnagar (River bed exposures predominant)

c) E, NE & SE of Himatnagar (Hilly exposures predominant)

EXPOSURES AROUND HIMATNAGAR

The exposures lying 5-6 km around Himatnagar town occurring in the river bed of Hathmati and lowlying areas are included in this unit. The individual exposures have been described as (i) River bed exposres and (ii) Lowlying exposures.

i) River Bed Exposures

In the river bed of Hathmati excellent exposures of sandstones are seen in the vicinity of Dhandha Mehtapur and Himatnagar. Near village Dhandha, on the right bank thin layers of sandstones rest over the weathered granitic material. The sandstones are grey to brown in colour, mostly medium grained occasionally coarse grained, sub angular to sub rounded, hard,

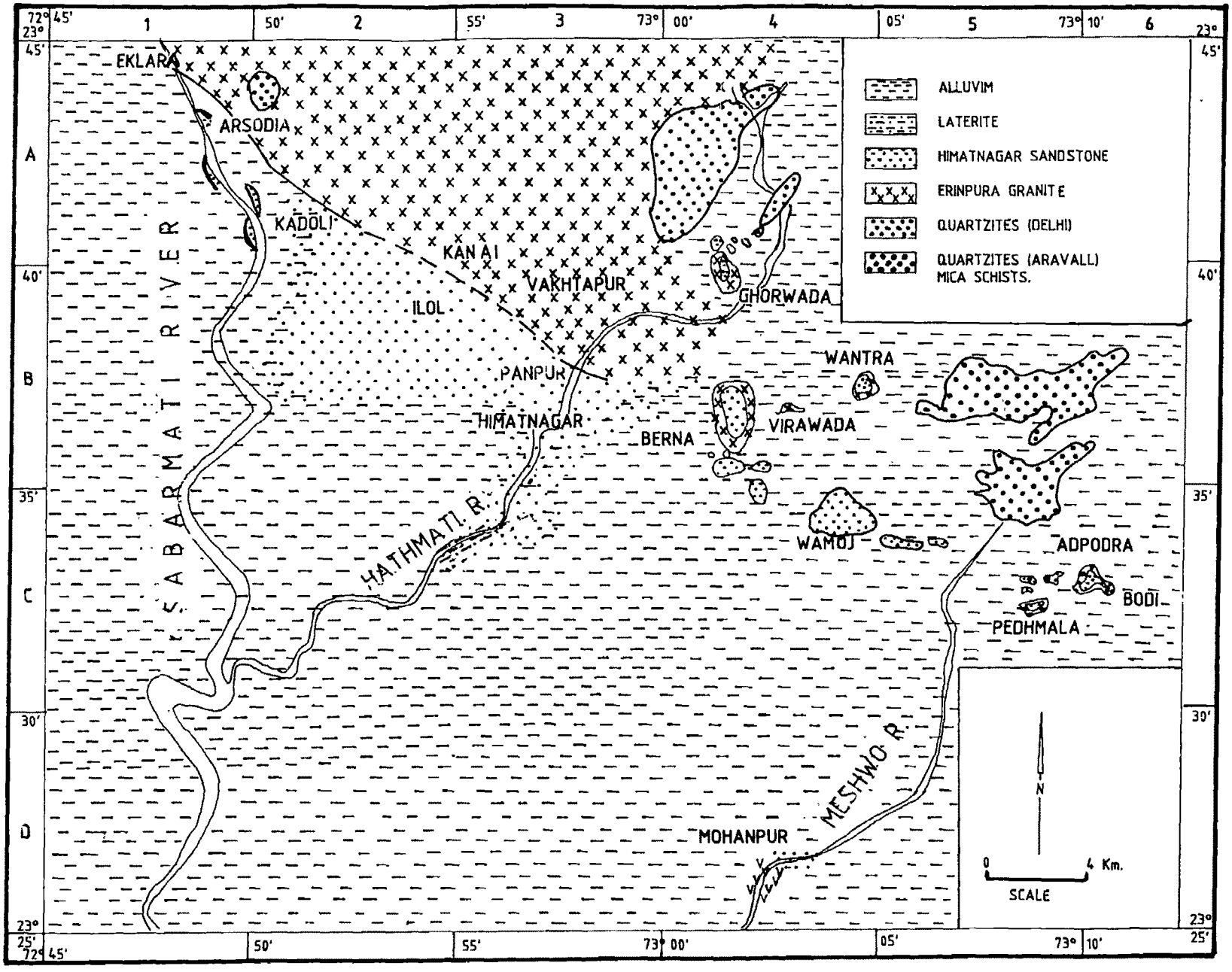


FIG. III 2. GEOLOGICAL MAP OF THE HIMATNAGAR AREA

TABLE III.2 DISTRIBUTION OF HIMATNAGAR SANDSTONES

NW of Himatnagar		Around Himatnagar		E, NE & SE of Himatnagar		
Sabarmati River Bed	Lowlying/ Quarry	Hathmati River Bed	Lowlying/ Quarry	Meshwo River Bed	Lowlying	Hill Top
Arsodia	Ilol	Himatnagar	Panpur	Mohanpur	Berna	Ghorwada
Kadoli	Kadoli	Dhandha	Mehtapur	NE Mohanpur	Bhavpur	Berna
Phudhera	Arsodia		Dhandha		Himatnagar)	Gamdi
E of Arsodia					Shamlaji Rd.)	Wantra
NE of Ilol					N of Hatharol	Wamoj
Saptmesh Temple					Rupal	Pedhmali
Pedhmali					Ranasan	Adpodra Bodi

and compact, and ferruginous forming scour channel. This marks the unconformity between weathered granite and Himatnagar sandstones.

About 1 1/2 km further down stream to the east of Hathmati bridge near Mehtapur on both the banks of river the sandstone exposures are met. On the right bank of the river the sandstones are brown to dark brown in colour, medium to fine grained, sub angular to sub-rounded in texture. Ferruginous nodules & egg shaped concretions are seen embedded within the sandstones (Plate III.1). While on the left bank the sandstones are pink to brown in colour and medium to fine grained. The ferruginous concretions are seen in the upper parts only. About 1 km further downstream on the right bank, the sandstones show fining upward sequence; the detailed lithological description is given in Table III.3.

Further 1/2 km downstream near Himatnagar on the right bank, the exposures of sandstones are white, grey, brown in colour and medium to fine grained. They show stratification and current bedding with westward (260°) current direction (Plate III.2). At places ferruginous concretions (3 to 5 cm dia.) are seen. The sandstones show well developed master joints (Plate III.3), the prominent being 45°/78° SE. The top portion of sandstones is totally ferruginous. The ferruginous band is oblique to the bedding plane. Further 3/4 km downstream in a cliff section on the right bank of river the sandstones are horizontal to sub horizontal and show planar and trough cross stratification (Plate

PLATE III.1

Ferruginous Nodules in Himatnagar Sandstones
(Loc : Hathmati River Near Mehtapur)

TABLE III.3 FINING UPWARD SEQUENCE

(Sandstones of Hathmati River - Himatnagar)

Layers from top	Thickness in m	Grain size	Lithological Description
1	0.3 m	fine	Mainly white in colour, occasionally yellow, very fine grained, sub-rounded unconsolidated with promi-nent mica, flakes and grains of mafic minerals.
2	0.4	fine	White occasionally yellow fine grained sub-rounded with mica flakes and mafic mineral grains.
3	0.5	fine	Generally white, fine grained, sub-rounded unsolidated. Mica-flakes and grains of mafic minerals are less than the overlying sandstone.
4	0.4	fine	Mainly white, at places pink, brown, yellow, fine grained, sub-rounded with mica flakes and grains of mafic minerals.
5	0.3	fine to	White and colourless occasio-nally yellow; medium to fine medium grained, sub-rounded, unconsolida-ted with mica flakes and grains of mafic minerals.
6	0.4	medium	White to colourless, at places to pink, yellow; coarse to medium coarse grained, sub-angular, with mica flakes. Mafic minerals are less.
7	0.5	coarse	Colourless and white, at places yellow; mainl coarse grained with medium grained also, sub-angular, poorly consolidated. The mica flakes and mafic minerals are less than the overlying sandstones.

- BASE UNEXPOSED -

PLATE III.2

Field Photograph Showing Cross-Stratification
in Sandstones
(Loc : Hathmati River at Himatnagar)

PLATE III.3

Vertical Joints in Sandstones
(Loc : Hathmati River at Himatnagar)

III.4). In the sandstones the true bedding is marked by yellow and brown coloured bands. The cross bedding shows different current directions but at places they strike E-W with moderate (30° to 35°) dip due N. Generally the true beddings are horizontal or westerly dipping. These sandstones are poorly consolidated and the silica is being mined from these exposures. These sandstones are overlain by 2-4 m thick white, grey, brown, medium to fine grained, moderately hard sandstones with 15-20 dip due SW. The bedding is characterised by alternate light and dark laminae (Plate III.5). At places joints are developed and due to wateraction through the leached portion the sandstones have developed hard, compact brownish colour nodular material. Further south in the river bed of Hathmati river at Himatnagar, the sandstones are white, grey, yellow, brownish in colour-mainly fine grained, sub rounded with 15°-20° dip due SW.

b) **Low Lying Exposures**

The sandstone exposures of this category form isolated outcrops occurring either in quarry section (Plate III.6) or under thin veneer of alluvium in the vicinity of Himatnagar town. Good exposures of sandstones are met near village Panpur, Dhandha, Mehtapur and on Ilol & Vijapur road. The description of individual exposures is as under.

PLATE III.4

Field Photograph Showing Festoon Cross Stratification in Sandstones (Loc : Hathmati River at Himatnagar)

PLATE III.5

Field Photograph Showing Alternate light and dark laminae in sandstones (Loc : Hathmati River Bed at Himatnagar)

PLATE III.6

Sandstone Quarry Section of Panpur
Showing Three Sets of Joints

Mehtapur Exposures

About 1 km from Himatnagar, at the bifurcation of Idar-Vijapur road near village Mehtapur, the sandstones are mostly white to buff in colour with dark coloured bands. These are medium to fine grained and sub-angular to sub-rounded. They show E-W strike with low to moderate dips (upto 25°) due south (Plate III.7). About 1 km from Mehtapur towards Vijapur on the right side of road, the sandstones are well stratified in the lower part and show current bedding (Planar) with current direction 210°. They contain ferruginous concretions (Plate III.8) and lenses of fine grained sandstones within the medium grained sandstones. In a 6 to 8 m. thick quarry section the sandstones provide evidences of atleast three cycles of fining upward sequence (Table III.4).

Very close to this quarry section on the right side of road, opposite to P.W.D. office, the sandstones show fault breccia and strong slickenside lineations with moderate to high plunge (55° to 60°) in the ENE direction (Plate III.9). Again on the left side of road, opposite to earlier exposure the fault breccia is seen. These observations clearly indicate a post depositional faulting. A few meter ahead, the sandstones show 45°/25° SE strike and are characterised by cross beddings showing westerly current direction.

PLATE III.7

Moderate Dips in Sandstones
(Loc : Mehtapur)

PLATE III.8

Sandstones Showing Sedimentary Beddings
and Ferruginous Concretions
(Loc : Mehtapur)

A Closer View of Above

TABLE III.4 FINING UPWARD SEQUENCE

(Sandstones near Mehtapur)

Layers from top	Thickness in m	Grain size
1	0.5	medium grained
2	0.3	fine grained
3	0.5	medium grained
4	0.3	medium grained
5	0.3	medium grained
6	0.6	coarse grained
7	0.6	fine grained
8	0.5	fine to medium grained
9	0.6	medium grained
10	0.5	coarse grained
11	0.3	fine grained
12	0.5	medium grained
13	0.4	medium to coarse grained
14	0.5	coarse grained

BASE NOT EXPOSED

PLATE III.9

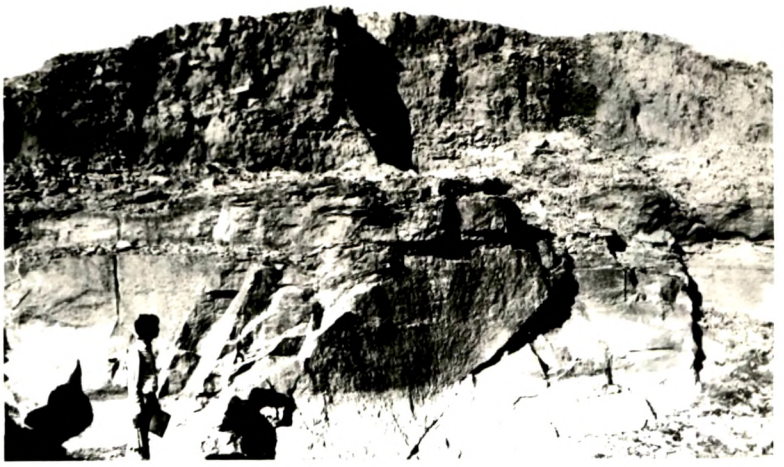
Fault Breccia in Sandstones
(Loc : Mehtapur)

Panpur Exposures

About 5 km NW of Himatnagar, excellent exposures of sandstones occur near Panpur. The name Panpur means the village of stone where extensive quarrying of sandstone is in progress since last many years. They form the numerous isolated sandstone exposures. The most prominent exposures lie at about 1 1/2 km. E of village Panpur. Here the sandstone outcrops occur in quarries where the height is 15-20 m (Plate III.10). The outcrops trend almost NS. Their sudden appearence with lowlying alluvial terrain is perhaps suggestive of their N-S faulted contact. The presence of slickensides and highly crushed and brecciated nature of the rock give enough indication of this faulting (Plate III.11). 200 m NE to this exposure, under 2 to 3 m cap of alluvium, the sandstones (10 to 20 m) rest over Erinpura granites and further 1 to 2 km N near Virpur village only granites are encountered.

In Panpur outcrops the lower layers (8-10m), middle layers (1-1.5m) & upper layers (4-5m) are coarse grained, fine grained and coarse grained respectively. They show variegated colours in the tone of white, pink. purple, violet etc. and are sub angular to sub rounded. Current beddings are more common while graded bedding, cut & fill structures and ferruginous concretions are occasionally seen (Plate III.12). The fining upward sequence is clearly visible. Generally the beds dip 15°-20° due W or NW. Contemporaneous minor faults are seen at places (Plate III.13). The fault plane strikes 35°, dipping 60° due W to NW. The

PLATE III.10



View of Panpur Quarry Section

PLATE III.11

Development of Slickensides in Sandstones
(Loc : Panpur)

PLATE III.12

Sandstones Showing Ferruginous Concretions
and Cut & Fill Structures
(Loc : Panpur)

PLATE III.13

Shear Planes and Ferruginous Concretions in
Sandstones
(Loc : Panpur)

sedimentary bedding is marked by change in colour and grain size as a result, the distint layering is clearly visible. In these exposures the sandstone and shaly sandstone layers are separated by 25 to 30 cm purple coloured sandy material. Evidences of minor faulting and graded bedding are observed at places in this exposure.

Further 100 m towards Panpur village the sandstones are grey, buff, brown in colour, medium to fine grained, sub angular to sub-rounded with alternate ferruginous bands. The general strike of sandstone is N-S with 10°-35° dip due west (Plate III.14). They are characterised by the current bedding. The area seems to have undergone a very open N-S flexural folding. The eastern limb dips 10°-15°, the western limb shows 20°-30° dips. These flexures and shear-planes (joint planes) having N-S strike could be sympathetic to the N-S faulting (Plate III.15).

At village Panpur proper, the beds are dipping towards west and north showing domal structure that has given rise to quarry exposures above the ground level. At the western extremity of Panpur exposures, the rocks are gritty fine grained, sub angular to angular and ferruginous with fine lamination. The sedimentary bedding show the ENE strike with moderate dips due NW. The rocks at places show brecciation indicating a possibility of faulting.

About 2 km. from Panpur towards Ilol on the right side of road, the sandstones show ENE strike with low to moderate (10°-15°) dips due NNW. Strong slickenside lineations are developed at

PLATE III.14

Moderately Dipping Sandstones
(Loc : Panpur)

PLATE III.15

Vertical Joints in Himatnagar Sandstones
(Loc : Panpur)

number of exposures which show moderate to high plunge in the direction WSW. This clearly indicates that the sandstones have undergone faulting.

Dhandha Exposures

About 2 to 2 1/2 km. north of Himatnagar on Himatnagar-Idar road near village Dhandha, the sandstones are seen resting over the weathered granites. Here the loose & poorly consolidated rounded to subrounded pebbles of conglomerates are also encountered. The sandstone outcrops are not encountered north of Dhandha and near village Virpur, Vaktapur and Dolgarh only the isolated exposures of granites with intervening alluvium are seen.

EXPOSURES NORTH WEST OF HIMATNAGAR

The exposures of the Sabarmati river bed and nearby areas NW of Himatnagar are included in this group. The exposures comprise predominantly sandstones with subordinate clays, shales and conglomerates. These exposures have been described as (i) River bed exposures and (ii) Lowlying exposures.

River Bed Exposures

In a stream of a Sabarmati, NE of Ilol village basal conglomerates are exposed on which there lie the white, hard and compact sandstones with prominent mica flakes and opaque minerals

(Plate III.16). On the top of these rest the red and white coloured claystones horizon. The true beddings are sub horizontal dipping due west. These are characterised by planar cross stratification that strikes NW-SE with low to moderate dips (15°-20°) due SW; current direction being mostly westerly (232°-240°).

About 1 1/2 km east of village Arsodia in a stream of Dabhol Nadi conglomeratic sandstones are overlain by a shaly layer. It is grey in colour hard and compact, mostly fine grained with thin coarse layers. The rock is poor in mica flakes. These sandstones are overlain by a shale which is dark brown, violet in colour, very fine grained, hard compact and laterised.

On the right bank of Sabarmati river near Pedhmali the white to grey coloured fine grained, subrounded, poorly consolidated, horizontal to sub horizontal sandstones are overlain by brown coloured clayey layers (Plate III.17). Opposite to these exposures on the left bank near Kadoli, the sandstone exposures in the river bed are violet, buff, grey, white in colour, mainly fine grained with small intercalations of clay and shaly sandstone, occasionally lensoid in nature (Plate III.18) with pebbles of quartz and felspars. Their dips are due west. The shaly layers are characterised by minor flexrues (Plate III.19). Small pockets of china/fire clays commonly known as pipe clays, are encountered and might have resulted due to the accumulation of fine particles of clay as flood plain deposits. On the bank of Sabarmati river near Saptamesh temple, and Phudhera the

PLATE III.16

Field Photograph Showing Basal
Conglomerate Overlain by Sandstone
(Loc : Stream, NE of Ilol)

PLATE III.17

Field Photograph Showing Sandstone
Overlain by Clayey Layers
(Loc : Sabarmati River Near Pedhmali)

PLATE III.18

Lenticular Bedding in Himatnagar Sandstones
(Loc : Sabarmati River Near Kadoli)

PLATE III.19

Minor Flexures in Clayey Sandstones
(Loc : Sabarmati River Near Kadoli)

sandstones are fine grained and gritty showing horizontal to sub horizontal bedding planes. Occasionally these contain clayey and ferruginous layers. On the left bank of Sabarmati river near Arsodia the sandstones are mainly horizontal to sub horizontal with gentle dips due west and characterised by the cross stratification indicating current direction towards NW (Plate III.20). Here the unconsolidated sandstones are overlain by hard and compact shaly sandstone. These are fine grained white in colour with yellow and pink bands which mark the distinct sedimentary beddings. The graded beddings are also seen in these layers. About 100 m. south of these exposures the rocks in the river bed are lateritic and gritty and are characterised by botryoidal form. These exposures show their extension upto little north of Arsodia village in the river bed. Beyond this, the conglomeratic layers (Plate III.21) and the exposures of Erinpura granites are seen near village Eklara marking the northern limit of the deposition of Himatnagar sandstones.

Low Lying Exposures

About 1/3 km SE of village Ilol the sandstone exposures are pink in colour, medium to fine grained, occasionally coarse grained and sub angular to sub rounded. They show variegated dips towards N,E & W resembling domal structure. The predominant joints strike 160°/vertical. The lower coarse grained layers are overlain by shaly sandstones. About 1/2 km south of Ilol village in a quarry section the sandstones occur as thin beds (0.3-0.6 m) showing the variation in colour and grain size. The details of

PLATE III.20

Cross-Stratification in Himatnagar Sandstones
(Loc : Sabarmati River Near Arsodia)

PLATE III.21

Conglomeratic Horizon Exposed on the Left
Bank of Sabarmati
(Loc : North of Arsodia)

Ilol quarry section (Top to bottom) clearly suggest that there are atleast three cycles of fining upward sequences. (Table III.5).

Near Kadoli village in a 3 to 4 m thick quarry section, under the 0-1 m cap of alluvium, the sandstones show variegated colours and fining upward sequences. The lower layers are pink, white, smokey in colour, coarse grained, sub angular, moderately compact with opaque minerals. These are overlain by pink, brown and buff coloured, medium to fine grained sandstones. Mica flakes and opaque mineral grains are seen in handspecimen. These sandstones are overlain by white, pink, violet - mainly fine grained, sub rounded, hard and compact sandstones. About 2 km N of Kanada towards Arsodia, on either side of road gravel beds are met. Further in a nearby dug well only weathered granite is encountered below 1 m conglomeratic bed. Beyond this, towards north and east, the sandstones are not encountered suggesting the northern limit of the Himatnagar sandstones. About 1 km east of Arsodia the sandstones are pink, brown, mainly fine grained, moderately hard with shaly sandstones. The shaly sandstones contain unrecognisable fossillised wood and plant leaf impressions (Plate III.22). From the village Arsodia towards Sabarmati river, the sandstones are medium to fine grained; the surface is studded with ovoid ferruginous concretions, the nucleus being yellow with the outer ferruginous rim. The sandstones exhibit strong master joint having steeper, almost vertical dips with NW-SE strike. The strong slickensides show northwesterly orientation and moderate to high plunge. This

TABLE III.5 FINING UPWARD SEQUENCE

(Sandstones near Ilol)

Layers from top	Thickness in m	Grain size	Lithological Description
1	2	3	4
1	0.3 m	fine to medium	The sandstone is white, brown mainly fine to medium grained, in the lower part more concentration of coarse grains while in the upper part the fine particles shows the fining upward sequence. At places opaque mineral grains and mica flakes are also present.
2	0.4	medium to coarse	The sandstone is yellowish to to brown, medium to coarse grained. coarse The layer is highly altered to yellowish clayey and brownish iron bearing material.
3	0.3	fine	The sandstone is colourless to yellow with brown white bands mainly fine grained with micaceous flakes and opaque mineral grains.
4	0.6	fine	The sandstone is yellowish with small patch of white and violete colours mainly fine grained, occasionally medium grained, micaceous material is more with opaque mineral grains.
5	0.6	medium	The sandstone is brown medium grained sub-angular to sub-rounded and ferruginous.
6	0.3	coarse	The sandstone is brown, yellow in colour with pink band mainly coarse grained sub-angular to sub-rounded, the quartz grains are colourless to smoky with matrix of medium to fine grained quartz. They contains miaceous flakes and opaque mineral grains.

1	2	3	4
7	0.6	fine	The sandstone is colourless to to yellow in colour. At places coarse coarse grained sandstone is overlain by white and yellow fine grained sandstone with occasionally medium grained quartz with micaceous flakes and opaque mineral grains.
8	0.3	fine	The sandstone is colourless to white, mainly fine grained with minor medium grained, compact with micaceous flakes and opaque mineral.
9	0.3	fine	The sandstone is brown, dark brown at places white, mainly fine grained with isolated medium grained with micaceous and black opaque grains and the sandstone is highly ferruginous.
10	0.6	fine	The sandstone is characterised to by yellow, white brown and pink medium colour bands. It is mainly fine grained but at lower part the medium grains are seen which indicate the fining upward within the layer (graded bedding).
11	0.5	medium	The sandstone is white, brown, to yellow in colour, mainly coarse to coarse medium grained, sub-angular to sub-rounded with micaceous flakes.
12	0.5	coarse	The sandstone is brown, yellow and white, mainly coarse grained, sub-angular with mica flakes and opaque mineral grains.

- BASE UNEXPOSED -

PLATE III.22

Exposures of Shaly Sandstones
(Loc : 1 km East of Arsodia)

suggests faulting in the area. Further 200 m south the sandstone exposures show distinct layering. The graded bedding and cut and fill structures are also encountered. Besides, quartzites and weathered granites are also seen near village Dawad and Kanai respectively.

EXPOSURES E,NE & SE OF HIMATNAGAR

The sandstone exposures of this unit occur in the E, NE and SE part of Himatnagar. The most conspicuous exposures are seen on the eroded surfaces of the Erinpura granites and Aravallis at considerable height (195 to 243 m MSL) and are described as "Hill top exposures", where they rest over Erinpura granites at Ghorwada, Berna, Gamdi, Wamoj, Wantra, while at Pedhmala, Adpodra and Bodi they rest over Aravallis. The sandstones also form the isolated outcrops in the low lying area and river/stream beds. The individual exposures have been described as (i) River bed exposures (ii) Low lying exposures and (iii) Hill top exposures.

River Bed Exposures

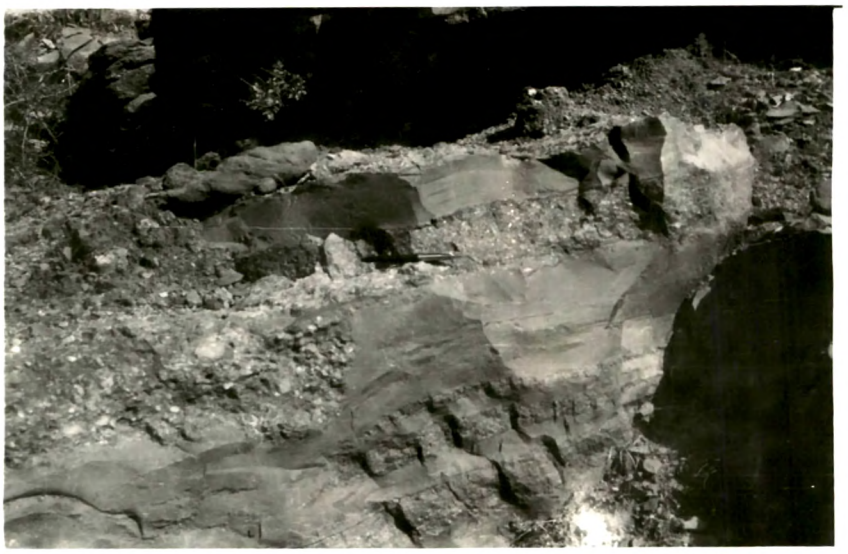
In the river bed of Meshwo near village Mohanpur the sandstones have faulted contact with Deccan Trap. The junction is very sharp and is marked by a fine cherty brecciated rock. The shearing and recrystallisation is of such a extent that this rock almost looks like a highly jointed quartzite. The trap/sandstone junction has NW-SE orientation. Numerous polished

surface like slicknesides are seen developed on this fault zone rocks. From Mohanpur to Ranasan in a stream, the sandstone exposures are mainly purple to dark green in colour, horizontally bedded, fine grained and occasionally contain cherty pebbles.

Low Lying Exposures

About 7 km from Himatnagar towards Shamlaji in a shallow dug well, below the 5-6 m alluvial cover the sandstone is encountered. This sandstone is buff to pale yellow in colour, medium to fine grained, poorly consolidated with prominent mafic minerals. On Himatnagar-Shamlaji road, near bifurcation of Berna village, in a shallow dug well below the cap of 5-6 m of alluvium, the sandstones are coarse to medium grained, hard, compact, recrystallised and gritty which gives a false appearance of quartz porphyry. The shaly sandstone contains the impression of plant fossils. The fossilised stem and leaves are also seen embedded in these sandstones. About 10 km from Himatnagar and 1 km before village Gamdi, to the north of Himatnagar-Shamlaji road the sandstone exposures show alternate fine and coarse lamination; the coarse one is yellow to colourless while the finer on is brown to grey in colour (Plate III.23). To the south of the road, the sandstones occur as three isolated small exposures at 15-20 m high from ground level. Generally they strike N-S with moderate dips (upto 30°) due west. In the northernmost exposure (near the road) the sandstones are mainly medium to coarse grained but at places fine grained. They are clayey and ferruginous. The top layers of the exposures are

PLATE III.23



Alternate Fine and Coarse Layers
in Sandstones
(Loc : 1 km West of Gandi)

medium to finegrained while the bottom coarse grained and gritty layers are forming the fining upward series. These exposures extend further southwards and near village Bhavpur where the sandstones form small isolated exposures occurring 5-7 m higher than ground level. The alignment of exposures is mainly E-W and sandstones are characterised by current beddings. In the vicinity of Rupal the sandstones form the patchy exposures peeping out the thin alluvial cover. They are mainly fine grained, sub-angular to sub-rounded, hard, compact and show cross stratification. From the nearby dug well sections it is clearly seen that these sandstones rest on granites hardly 10 m below the ground level. East of these, the exposures of sandstones on low lying areas are hardly met. About 2 km N of village Hathrol, the sandstones are seen occurring below 1 to 2 m thick alluvium. They show different colour bands and are coarse to medium grained, sub angular to sub rounded. At places, the gravelly conglomerates occur within these sandstones. Beside this the exposures of granite are seen near village Virawada.

Hill Top Exposures

The northernmost exposures of Himatnagar sandstone are met in this unit near Ghorwada and occur on the granite hill (243 m). These exposures are 1.5 km x 0.75 km in dimension and have almost N-S elongation. The sandstone is colourless to pink, mainly medium to fine grained, sub-angular to sub-rounded, compact and appear to be recrystallised. At places small dark coloured grains are seen which could be perhaps heavies. Ill defined

sedimentary beddings are also preserved. The thickness of sandstone is about 40 mts. About 5-6 km south of Ghorwada, the sandstones are seen on the top of granite hill near the village Berna; the elevation being 213 m MSL. The contact between sandstone and granite is seen at this exposure. The hill is 2.5 km x 1.5 km in dimension and comprises the basal conglomerate, coarse grained sandstone followed by fine grained sandstones. The thickness of sandstone is about 40 mts. The sandstones show current bedding, low dips (5°-10°) with occasional ferruginous concretions. About 3 km SE of Berna, more or less continuation of Berna hilly ranges, good exposures of sandstones are seen at village Gamdi (about 10 km from Himatnagar towards Shamlaji). They are capping the granitic hill at the elevation more than 180 m MSL. The sandstones are of variegated colour, medium to coarse grained, sub angular to sub rounded, hard, compact and recrystallised. The sandstones show generally low dips in W and SW direction. Small scale cross beddings are also seen. Occasionally the sub rounded to sub angular quartz pebbles occur along the bedding plane indicating another cycle of deposition. Impressions of fossilised wood are also seen in some exposures. Near Wamoj, 3 kms. SE of Gamdi village, the sandstone exposures form the series of small isolated hillocks in a NW -SE alignment. The elevation of exposures gradually reduces southeastward towards the village Dhundha and south of village Bhavpur it passes below the cap of alluvium. From Wamoj onwards, towards Bhavpur the trend of surface exposures changes from NW-SE to almost E-W. In this area the elevation of sandstone exposures

varies from 175 to 195 m MSL. The sandstones are mainly fine grained, sub-angular to sub-rounded and show current bedding. At places they are cherty and ferruginous with occasional thin layer of basal conglomerates. About 15 km from Himatnagar town and 3 km north of National Highway No.8 and 6.5 km east of Berna village, good exposures of sandstones (40 m thick) occur at the top of granite hill near village Wantra. The hill is of 2 km x 2 km in extent with the elevation of 241 m from MSL. The sandstones are pink and brown in colour, mostly coarse to medium grained and at places fine grained, sub angular to sub rounded, almost horizontal and characterised by the true bedding and cross laminations. The cross beddings strike N-S with 25°-30° due west. At places cross beddings show variation in current direction, the top sets are angular & the bottom sets are truncated to the true beddings. The sandstones are highly recrystallised and possess a quartzitic appearance. Occasionally gravel beds within the sandstone layers are also met in some sections. About 23 km SE of Himatnagar and 9 km SE of Wamoj at village Pedhmala yet another exposure of sandstone is seen capping the hill of Aravalli quartzite at an altitude of about 200 m from MSL (Plate III.24). The sandstones are buff to pink and brown in colour. They are mainly medium to coarse grained, sub-angular to sub-rounded, compact, hard and recrystallised. About 2.5 km NNW of Pedhmala and 1 km before the village Adpodra, to the south of the road between Rupal to Adpodra, the sandstones occur at an elevation of 200 m from MSL. The trend of the hill is mainly E-W. These sandstone are yellow, brown in colour, fine to medium grained, sub angular to sub rounded, hard, compact and

PLATE III.24

Flat Topped Sandstone Hill Near Pedhmala

recrystallised. Very near to this elevated exposures in a low terrain, the samples from the dug well reveal that the lower part is conglomeratic followed by medium grained and fine grained recrystallised sandstone at the top indicating a fining upward sequence present in these sandstones. About 2.5 km SE of Adpodra village and about 19 km from Modasa town, the sandstone exposures are seen occuring on the top of Aravallis (Mica schists) near village Bodi, at the height of about 200 m from MSL. The hill is about 2 km x 0.5 km in dimension. The lower part of the sandstone exposures is conglomeratic (Plate III.25). The unconformity between Aravalli mica-schists and Cretaceous conglomeratic sandstones is clearly seen. These exposures mark the limit of Himatnagar sandstones as only Aravallis are met further east.

PLATE III.25

Himatnagar Sandstones with Basal
Conglomeratic Horizon Near Bodi