CHAPTER - VI

TECTONIC FRAMEWORK

GENERAL

In order to understand the tectonic framework of Himatnagar area, it is necessary to know the tectonic set up of the neighbouring areas that has played a significant role in the present disposition of Himatnagar sandstones in northwestern India. It has been already mentioned earlier that the Himatnagar sandstones and Nimar sandstones of Mainland Gujarat, Dhrangadhra-Wadhwan sandstones of Saurashtra and Bhuj sandstones of Umia series in Kutch are of Cretaceous age. The Cretaceous sandstones are also encountered sub-surface in the northern part of Cambay basin (Desikacher 1971, Mukherjee, 1983).

The northwestern part of Indian peninsula is characterised by major, lineaments like Kutch rift, Cambay rift and Narmada rift with Saurashtra (Kathiawar) Horst and Surat Depression (Fig. VI.1). These major lineaments (rifts and horsts) styled by a conjugate system of three principal Pre-Cambrian orogenic trends viz. (i) Dharwar (NNW-SSE) (ii) Delhi-Aravalli (NE-SW) and (iii) Satpura (ENE-WSW) and their subsequent reactivations in Mesozoic and Cenozoic Eras have given rise to the Kutch, Saurashtra, Cambay and Narmada basins (Biswas, 1982, 1983, 1987; Raju & Srinivasan, 1983). The tectonic configuration of each trend has been discussed as per below :

(a) **Dharwar Trend**

Rifting along this trend resulted in separation of India from Africa in Early Jurassic period (Biswas, 1983). The west coast margin with series of narrow linear passive horsts and grabens is along NNW-SSE Dharwar trend. A prolific petroliferous Cambay Basin is also mainly along this trend (Raju & Srinivasan, 1983).

(b) **Delhi-Aravalli Trend**

This trend is conspicously characterised by narrow elongated NE-SW trending sub-parallel elevated ridges in the eastern part of North Gujarat. This trend also continues in the west upto Saurashtra horst across Cambay Basin, and in Kutch perhaps the

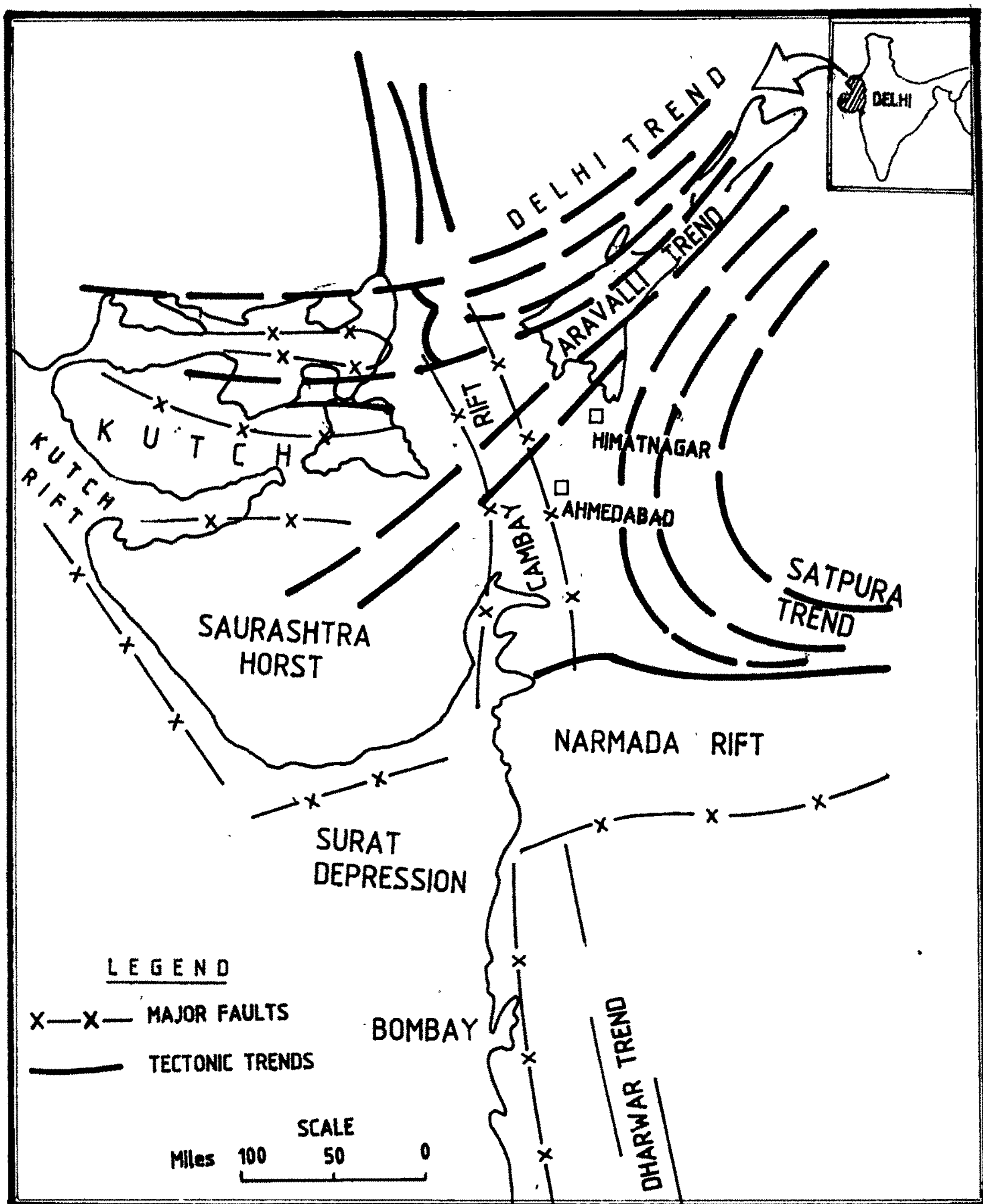


FIG. VI 1.
PERICRATONIC RIFT BASINS WITH MAJOR STRUCTURAL LINEAMENTS
(AFTER BISWAS, 1987,)

Delhi trend swings to E-W giving rise to a series of step faults in Kutch rift (Biswas, 1982).

(c) **Satpura Trend**

This (ENE-WSW) orogenic trend is a major tectonic boundary (West, 1962; Mathur et al., 1968) which divides the Indian shield into southern peninsular block and northern foreland block. Narmada-Son lineament or geofracture is also running parallel to Satpura trend. Although Cambay Basin is a major Dharwar (NNW-SSE) trending rift, the transverse ENE-WSW aligned numerous faults related to Satpura trend are responsible for dividing the basin into four tectonic blocks viz. Narmada block, Jambusar-Broach block, Cambay-Tarapur block and Ahmedabad-Mehsana block (Fig. VI.2)

BASIN CHARACTERISTICS

TECTONIC SET UP

The regional tectonics of NW India during Mesozoic has been reflected in the various research contributions by Biswas (1982,1983,1987). The Pre-Cambrian basement lineaments and the successive reactivations have played an important role in controlling the structural style of various sedimentary basins in western India. These reactivations have given rise to intracratonic and marginal basins in this part of subcontinent. The predominance of one trend with subsidiary cross trends depends upon the relative time of rejuvenation of lineaments in the adjacent cratons. Katz (1979) demonstrated that Pre-Cambrian

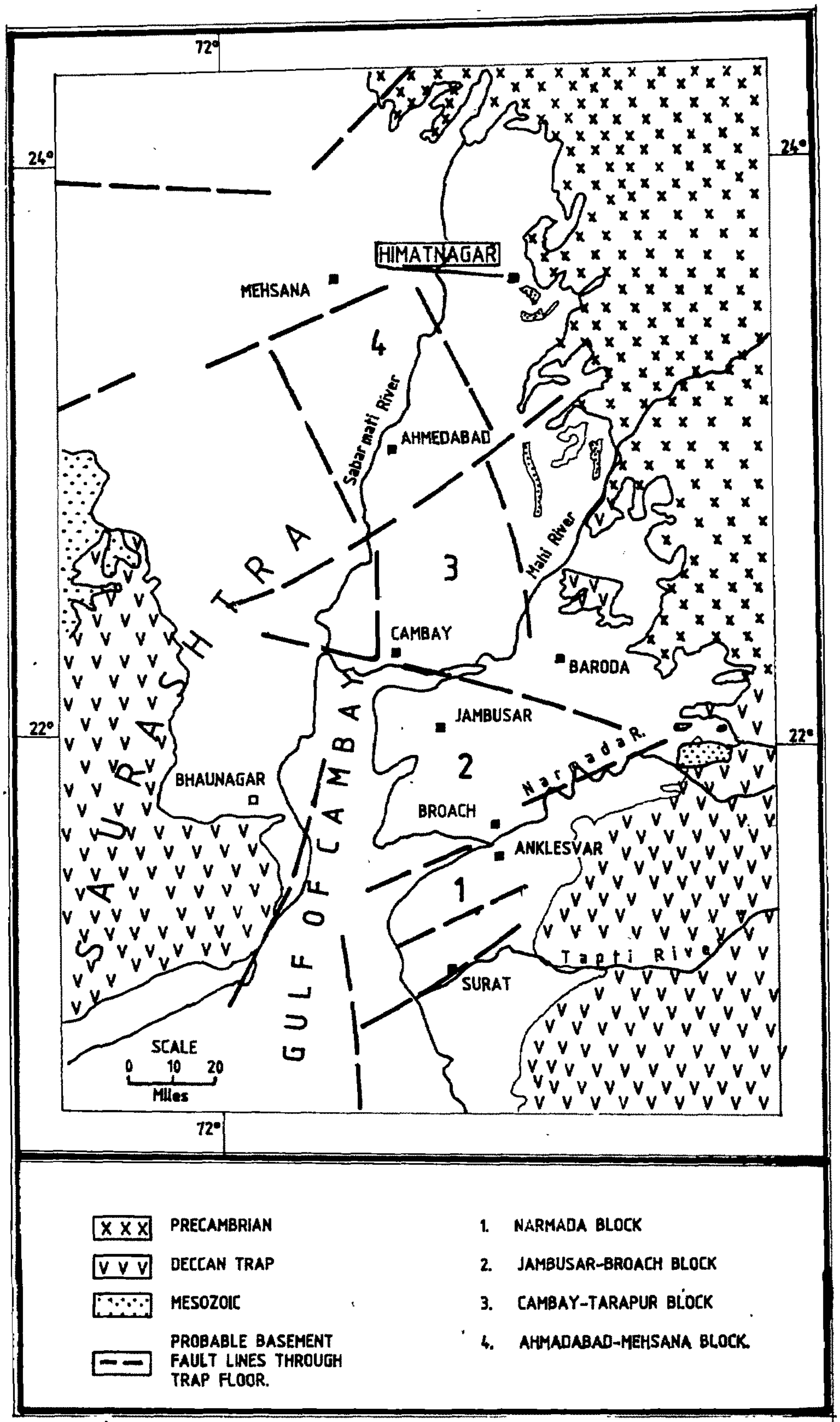


FIG. VI 2 TECTONIC BLOCKS-CAMBAY BASIN
(BASED ON MATHUR, 1968 & RAJU 1968)

lineaments were rejuvinated in Mesozoic (Tertiary) time to form rifts or basins Biswas (1987) considered that the Kutch, Cambay and Narmada basins were originated in different periods during Mesozoic Era, each one showing varying thickness of Mesozoic sediments. Again Kutch and Narmada basins are Mesozoic basins, whereas the Cambay basin is mainly a Tertiary basin. (It originated during Mesozoic but subsided at a greater rate during the Tertiary). The tectonic evolution of the three basins is correlatable with the various stages of drifting history of Indian sub continent, since its break up from Gondwanaland until its collision with Eurasia. The rifting developed sequentially from north to south. Kutch basin was formed in Early Jurassic period giving rise to the sedimentation from Mid-Jurassic. This was followed by Cambay basin in Early Cretaceous during which the Saurashtra remained positive area, evidenced by the presence of Lower Cretaceous sequence in Saurashtra. The Narmada Basin is of Late-Cretaceous age as the stratigraphic sequence from Upper Cretaceous onwards is encountered.

The evolution of these three basins is synchronous with the important events in the evolution of the Indian sub continent, its break up from the Gondwanaland in Late Triassic-Early Jurassic gave rise to Kutch basin, while its northward drifting during Jurassic Cretaceous was responsible for developing Cambay and Narmada basins. The close of Mesozoic Era is witnessed by the tectonic activities that gave rise to the numerous tensional faults triggering off stupendous volcanic activities along ancient lineaments. This caused cessation of the Mesozoic sedimentation in the above basins.

SEDIMENTARY BASINS

In order to understand the sedimentation and tectonic framework of the study area in relation to the regional consideration, a broad account of Kutch, Saurashtra, Cambay and Narmada basins is given in the following text.

Kutch Basin

According to Biswas (1983,1987) the Kutch basin opened up in Late Triassic to Early Jurassic period along Delhi trend wherein the sediments of Late Triassic (?) to lower Cretaceous age are deposited in a sub littoral to deltaic environments on a Pre-Cambrian granitic basement, unexposed in Kutch. These Mesozoic sediments were uplifted and folded and were covered by Deccan Traps in Late Cretaceous to Early Paleocene time and followed subsequently by Tertiary-Quaternary deposition.

Saurashtra Basin

The Saurashtra basin forms a horst lying to the south of Kutch rift, west of Cambay graben and north of Surat depression. The sedimentation in this area commenced during Early Cretaceous over the Pre-Cambrian basement when the rocks of Dhrangadhra formation deposited mainly as delta, channel, flood plains and levee deposits. This was followed by a marine trangression

(Aptian-Albian age) giving rise to the Wadhwan Formation, correlatable with the Ukra beds of Umia series in Kutch. The paleocurrent analysis within Dhrangadhra sandstones indicates unidirectional westward current (Bhandari & Suresh Kumar 1970); the provenance being from Delhi-Aravallis and Erinpura granites from east, across Cambay Basin. The pollen studies from Dhrangadhra Formation is indicative of coastal environment (Verma & Rawat, 1964). Additionally the absence of microplankton and presence of pteriodophytic spores suggests large influx of fresh water during the deposition of Dhrangadhra Formation. The palynological studies assigns Lower-Cretaceous (Neocomian-Aptian) age to this Dhrangadhra Formation. This was followed by Deccan volcanism and Cenozoic sediments.

The structure and tectonics of the Saurashtra area is mainly characterised by the NE-SW (Aravalli) trend although ENE-WSW (Satpura) trend is also seen in the igneous plugs within Deccan trap country of central Saurashtra. The principal uplifting took place during Late-Cretaceous period (Biswas, 1983).

Cambay Basin

Cambay basin is a intracratonic rift graben between Saurashtra uplift and Aravalli ranges, extending roughly in N-S alignment from North Gujarat through Gulf of Cambay to further south. In the northern part of the basin the oldest Pre-Cambrian granites are overlain by 40 to 345 m thick sandstones which are deposited under continental environments (Desikachar, 1971; Mukherjee, 1983).

The tectonic history of Cambay basin during Mesozoic is yet to be fully understood. The close of Mesozoic is characterised by tensional faults along ancient basement trends accompanied by large scale volcanic activities (mainly basalts) which constitutes the Tertiary floor of the basin (Raju & Srinivasan, 1983). The Cambay basin came into existence essentially during Tertiary period and its generalised stratigraphy is illustrated in Table VI.1.

Narmada Basin

Narmada basin is ENE-WSW graben bounded by system of sub-parallel, dextral wrench fault slightly diverging towards west (Das & Patel, 1984) forming a narrow graben along the Narmada-Son geofracture. The rifting was initiated in Late Cretaceous time giving rise to disconnected patchy outcrops. The Nimar sandstones (Bagh beds) were deposited by the river system flowing along the Narmada lineament. At the western margin of the basin where river intersects the Cambay graben, the deltaic facies of Nimars were deposited. The valley opened up into a rift basin in Late Cretaceous and the marine sediments were deposited in a progressively deepening environment until the end of Cretaceous. This period of Late Cretaceous transgression is synchronous with that of the eastern continental margin and the regression of Mesozoic sea from Kutch. This was followed by the Deccan Trap

TABLE VI.1 STRATIGRAPHY OF CAMBAY BASIN

Blocks ------>	Narmada	Broach	Cambay-Tarapur	Ahmedabad-Mehsana
Age	**Formation**			
Recent to Pleistocene	<---- GUJARAT ALLUVIUM ---->			
Pliocene	<-- JAMBUSAR --> BROACH			
Miocene	<---- JHAGADIA ----> <---- KAND ----> <---- BABAGURU ---->			
Oligocene/ Late Eocene	<-- DHADHAR -->		<-- TARAPUR -->	
Middle Eocene	ANKLESHWAR UPPER CAMBAY SHALE		VASO	KALOL KADI
Early Eocene	MIDDLE CAMBAY SHALE LOWER CAMBAY SHALE			
Paleocene	OLPAD/VAGHADKHOL			OLPAD
Late Cretaceous	<---- DECCAN TRAPS ---->			
Cretaceous to Up Jurassic				SERAU
Pre-Cambrian	<---- GRANITES ---->			

(Based on Chandra & Chowdhary, 1969 and Raju & Srinivasan, 1983) eruption and deposition of sediments of Tertiary- Quaternary periods.

STUDY AREA

The geological set up of Aravallis Delhis, Erinpura granites and the Himatnagar sandstones as also the available sub-surface geological data all remained of much help in understanding the tectonic configuration that took place during and after the deposition of Himatnagar sandstones. Based on the field observation of various outcrops and sub-surface data from dug/bore wells, the author in the following text has attempted to construct the tectonic framework of Himatnagar area.

(A) Field Evidences

In the study area the Himatnagar sandstones occur generally either as capping the hill tops of the elevated Aravalli quartzites, schists and Erinpura granites or occupy the low lying terrains forming the river bed and quarry exposures of low relief. To the E and NE of Himatnagar town, amidst the peneplained alluvial terrain, three prominent isolated hills near Ghorwada (243 m), Berna (213 m) and Wantra (241 m) comprise Erinpura granites. The flat tops of these hills are overlain by Himatnagar sandstones. The base of sandstones of Ghorwada, Berna and Wantra shows 200 m, 170m and 200 m altitudes respectively. These indicate that the sandstones in all these three hills possess almost same thickness i.e. around 40 m. The ground level of all the three hills is around 160 m (MSL).

The difference between the base of the sandstones and the present day ground level at Ghorwada, Wantra and Berna is 40m, 40m and 10m respectively. The distance between Ghorwada and Berna as also between Wantra and Berna is about 6 km and the ground level at all these localities is uniform (160m MSL) suggesting uniform erosion of the intervening areas which rules out erosion as the cause of the level difference at top of granite in these hills. The elevation difference at Berna in respect to Ghorwada and Wantra could be due to (i) higher dips of the sandstone beds (ii) non-uniform erosion of the hilly terrain or (3) tectonism. The difference in elevation due to high inclination of sandstones is ruled out as these rocks are almost horizontal to very low dips, even today. The almost equal ground level (160 m) and similar thickness (about 40m) of sandstones at these hills also does not support the non uniform erosion. Hence the elevation difference at these hills could be explained only due to tectonism. Nearly same thickness of these sandstones at all the three hills also supports this contention.

About 22 km SE of Himatnagar town the exposures of almost horizontally bedded sandstones rest at a height of about 200 m (MSL) on Aravallis near Adpodra & Bodi (212 m) and Pedhmala (205 m) villages. Near Adpdra and Pedhmala these rocks cap the quartzites while at Bodi they overlie the Aravalli schists. The thickness of the sandstones is about 10-15 m. The ground level has an altitude of about 160 m (MSL). The capping of sandstones in different types of Aravalli rocks is due to their original intercalated nature. West of this, the sandstones (10-20m thick) occur on weathered granites below the thin veneer of alluvium as encountered in the various well sections.

Further 11 km SW of Pedhmala in the Meshwo river bed near Mohanpur the NW-SE trending faulted contact between the sandstones and Deccan Traps is clearly visible. The presence of strong slickenslides on the joint/fault planes, highly brecciated nature of rocks near Mehtapur, Panpur, Ilol and Arsodia indicates the faulting. Additionally the local tilting of rocks substantiates the tectonism in Himatnagar area.

(B) **Subsurface Evidences**

With the help of the sub surface geological data collected from the dug/bore wells the author has attempted to reconstruct the tectonic framework of the study area by preparing structure contour maps, isopach maps and subsurface geological sections. The depth levels of the various top and bottom lithounits viz. Deccan traps, Himatnagar sandstones, and Erinpura granites from the ground level at individual localities have been collected. Their reduced levels were than recalculated with respect to MSL. (Table VI.2). The reduced levels on top of Deccan trap, Himatnagar sandstones and Erinpura granites were used for the preparation of structure contour map on that level. The isopach maps have been prepared by taking the thickness (top to bottom) of Himatnagar sandstones and Deccan trap.

TABLE VI.2 SUB SURFACE INFORMATION OF HIMATNAGAR AREA (BASED ON DUG/BORE WELLS)

LOCATION WITH SURFACE ELEVATION (MSL)	REF. LOCALITY NUMBER	Depth in m from surface - Top to Bottom (and thickness) with levels from MSL (given in bracket)			
		ALLUVIUM	DECCAN TRAP	HIMATNAGAR SANDSTONES	ERINPURA GRANITES
1	2	3	4	5	6
AHMEDPURA 120	D/3 3	Surface-9 (120-111)	9-94 (85) (111-26)	94- (26)	-
AMODRA 131	D/3 4	S-36 (131-95)	36-52(16) (95-79)	52-101 + (49+) (79-30 +)	-
ANJANA 115	E/3 5	S-62	62- (53)		
ANTROLIWAS, PUNJAJI 120	E/4 6	S-21 (120-99)	21-82(61) (99-38)	82-120 + (38+) (38-MSL)	
BALISANA 105	E/2 9	S-140 (105-(-) 35)			
BUTAL 120	E/6 13	S-5 (120-115)	5- (115)		
DADARD 122	E/4 14	S-14 (122-108)	14-87 (73) (108-35)	87-170(83) (35-(-)48	170 (-48)
DALPUR 131	C/3 15	S-43 (131-88)	43-48(5) (88-83)	48-105(57) (83-26)	105 (26)
DEDHROTA 129	B/2 17	S-5 (129-124)	-	5-50(45) (124-79)	50 (79)
DEROL 122	B/2 18	S-47 (122-75)	47-95(48) (75-27)	95-195 + (100+) (27-(-)73)	-
FATEHPUR MOTA 133	D/4 24	S-15 (133-118)	15-42(27) (118-91)	42-104(62) (91-29)	104 (-101)

1	2	3	4	5	6
GADHODA 142	C/3 25	S-43 (142-99)	-	43-111(68) (99-31)	111 (31)
GHADI 114	D/3 29	S-65 (114-49)	65-119(54) (49-(-)5	119-215(96) ((-)5-(-)101)	215 (-101)
HADMATIA 118	D/4 32	S-10 (118-108)	10-22(12) (108-96)	22-98(76) (96-20)	98 (20)
HARSOL 110	E/4 33	S-28 (110-82)	28-98(70) (82-12)	98-200(102) (12-(-)90)	200 ((-)90)
HIMATNAGAR 140	B/3 35	-	-	S-100(100) (140-40)	100 (40)
ILOL 139	B/2 36	-	-	0-60(60) (139-79)	60 (79)
JITOD 140	C/3 38	S-32 (140-108)	32-42(10) (108-98)	42-125(83) (98-15)	125 15
KATWAD 130	C/2 43	S-62 (130-68)	-	62-106(44) (68-24)	106 (24)
KHERWADA 130	B/2 44	S-5 (130-125)	-	5-68(63) (125-62)	68 (62)
LAWRI 127	D/4 45	S-25 (127-102)	25-83(58) (102-44)	83-137+(56+) (44-(-)10+)	-
MAUCHHA 126	D/3 46	S-52 (126-74)	-	52-101(49) (74-25)	101 (25)
MAYAD 130	C/2 47	S-174	-	-	-
MOHANPUR 125	D/4 49	-	S	S-72(72) (125-53)	72 (53)
MOTACHELKA 120	D/4 50	S-15 (120-105)	15-33(18) (105-87)	33 (87)	
MOTESARI 120	E/3 51	S-30 (120-90)	30-103(73) (90-17)	103 (17)	

1	2	3	4	5	6
NADRI PATHAPUR 140	C/3 53	S-35 (140-105)	35-52(17) (105-88)	52 (88)	
NANANPUR 135	C/3 55	S-54 (135-81)	-	54-105(51) (81-30)	105 (30-)
NAVALPUR 135	C/2 56	S-19 (135-116)	-	19-132(113) (116-3)	132 (3)
POLAJPUR 130	C/2 61	S-28 (130-102)	-	28 (102)	-
PUNSARI 123	E/5 64	S-28 (123-95)	28 (95)	-	-
RANASAN 123	D/5 65	-	-	S-10(10) (123-110)	10 (113)
RANSIPUR 141	A/1 67	S-80 (141-61)	-	-	-
RUPAL 110	E/3 68	S-66 (110-44)	66 (44)	-	-
TAKHATGARH 120	D/4 70	S-10 (120-110)	10-37(27) (110-83)	37-93(56) (83-27)	93 (27)
TALOD 108	E/3 71	S-77 (108-37)	77 (37)	-	-
UMEDNI M[VADI 107	E/3 72	S-72 (107-35)	72-115(35) (35-(-)8+)	-	-
VARWADA 112	D/4 74	S-10 (12-102)	10-26(16) (102-86)	26-88(62) (86-24)	88- (24)
WADARD 114	D/2 79	S-143 (114-(-)29)	143 ((-)29)	-	-

REMARKS (1) All depths are in metres.
(2) The thickness of Himatnagar sandstone includes thin layers of clay/shales.

The structure contour maps are useful in deciphering the present day tectonic configuration of the subsurface rocks. The trends of contours suggest the alignment of that formation. The relatively widely spaced contour lines indicated low dipping strata or terrace like feature while the closely spaced contours i.e. considerable difference in the elevations between two places, suggest either the possibilty of fault or very steeply inclined rocks. In isopach maps, the area covered by the maximum value of contour suggests the principal centre of deposition and its trend suggests the direction of deposition from one of the either side. The area showing reduction in thickness suggests possibly the blank of depositional basin. The details of the structure contour maps as well as isopach maps are given in the forthcoming text.

(i) Structure Contour Maps

a) Erinpura Granites

The structure contour map on the top of Erinpura granites (Fig. VI.3) indicate that the contour trend is NNW-SSE (Dharwar) between Ranasan and Himatnagar which takes a swing to E-W (Satpura) between Himatnagar and Derol, NE-SW (Aravalli-Delhi) between Ilol and Dedhrota, swinging back to NNW-SSE further NW. These trends clearly suggest that the tectonic framework of Himatnagar area is controlled by the ancient basement grains at granite level. Based on the contour spacings, this structure contour map is divided into five zones, each one shows one or other characteristic tectonic features.

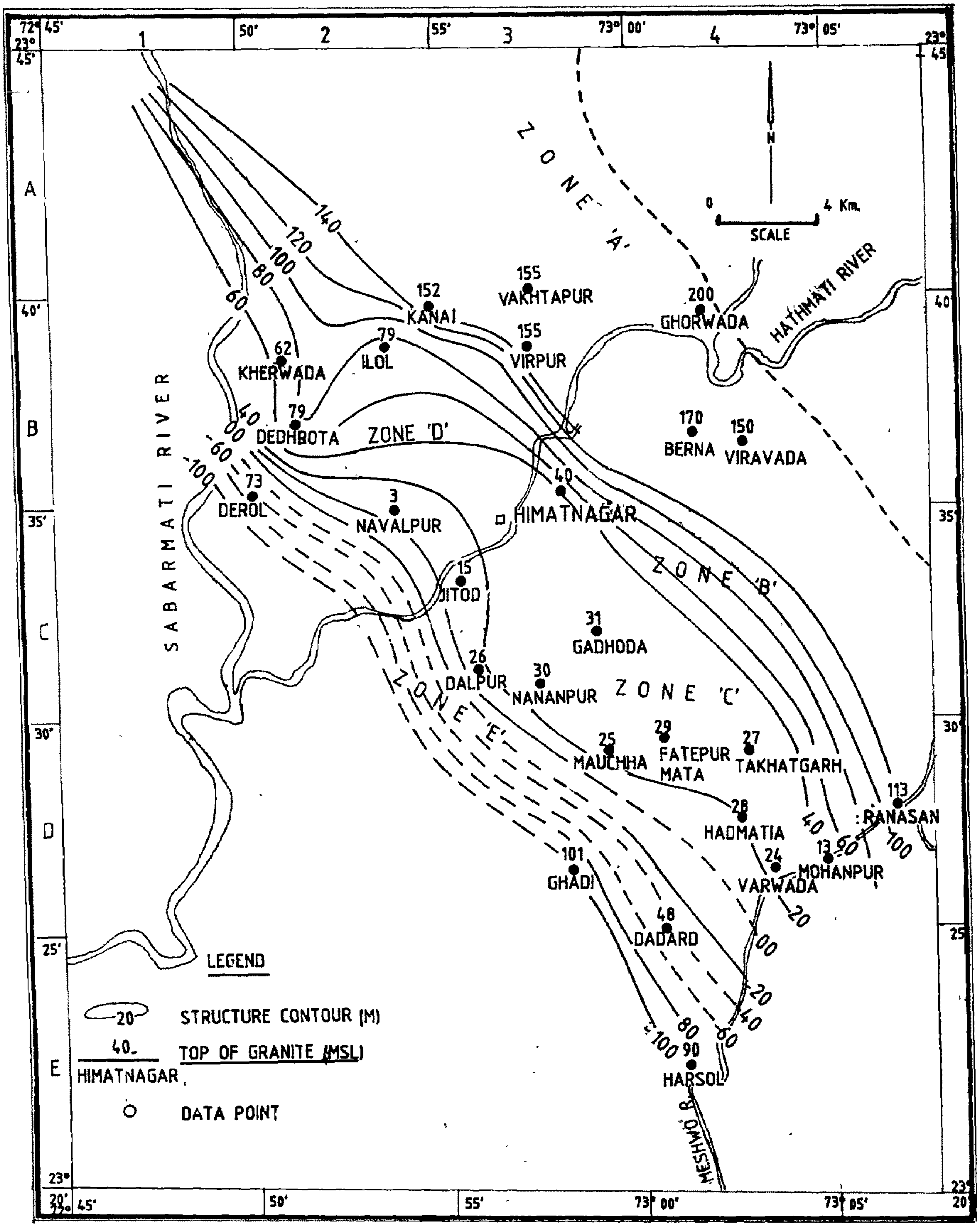


FIG. VI 3 STRUCTURE CONTOUR MAP ON TOP OF ERINPURA GRANITE.

Zone A

This zone mainly comprises the surface exposures occurring between 140 to 160 contours forming broad terrace like feature having elongation in NNW-SSE direction. This zone is characterised by the isolated elevated hills (170-200m) of flat topped granites underlying the Himatnagar sandstones.

Zone B

The closely spaced contours in this zone are due to sharp differences in the granite levels within a short distance viz. Ransipur (61m) & Eklara (140 m), Ilol (79m) & Kanai (152m), Himatnagar (40m) & Dhandha (145 m), Mohanpur (43m) & Ranasan (112 m). This abrupt difference in altitudes in short distance suggests the possibility of fault with southwestern downthrow. Its NNW-SSE alignment constitutes strike fault.

Zone C

This zone is characterised by a broad terrace like feature extending parallel to Dharwar (NNW-SSE) trend and occurs between 0 & 30 m (MSL). This feature suggests a relatively stable area in relation to surrounding ones.

Zone D

This zone is characterised by sudden swing of contour alignments from NNW-SSE to E-W suggesting possibly a transverse fault parallel to Satpura trend.

Zone E

This zone is identical to the zone B, showing NNW-SSE (Dharwar) trend with close contours suggesting a possibly strike fault with southwestern downthrow.

In general the structure contour map of Himatnagar area clearly indicates a regional NNW-SSE Dharwar trend with series of southwesterly step faults.

(b) **Himatnagar Sandstones**

The present day configuration of Himatnagar sandstones is clearly deciphered by this map. The predominant alignment is at Dharwar (NNW-SSE) trend. On the basis of spacing of contours the map has been divided broadly into five zones (Fig.VI.4) and described as per below.

Zone A

This zone of the area shows almost a NNW-SSE trending terrace like feature, occurring generally between 135 (Kherwada) and 160m (MSL) near Panpur, north of 160 m contour mark the limit of sandstones.

Zone B

This zone is again exemplified by a NNW-SSE trending terraced feature lying generally between 80-100 m (MSL); maximum being 116 m (Navalpur) and minimum 74 m (Mauchha). On the central and eastern part of the map the contours show EW and a local NE-SW trends.

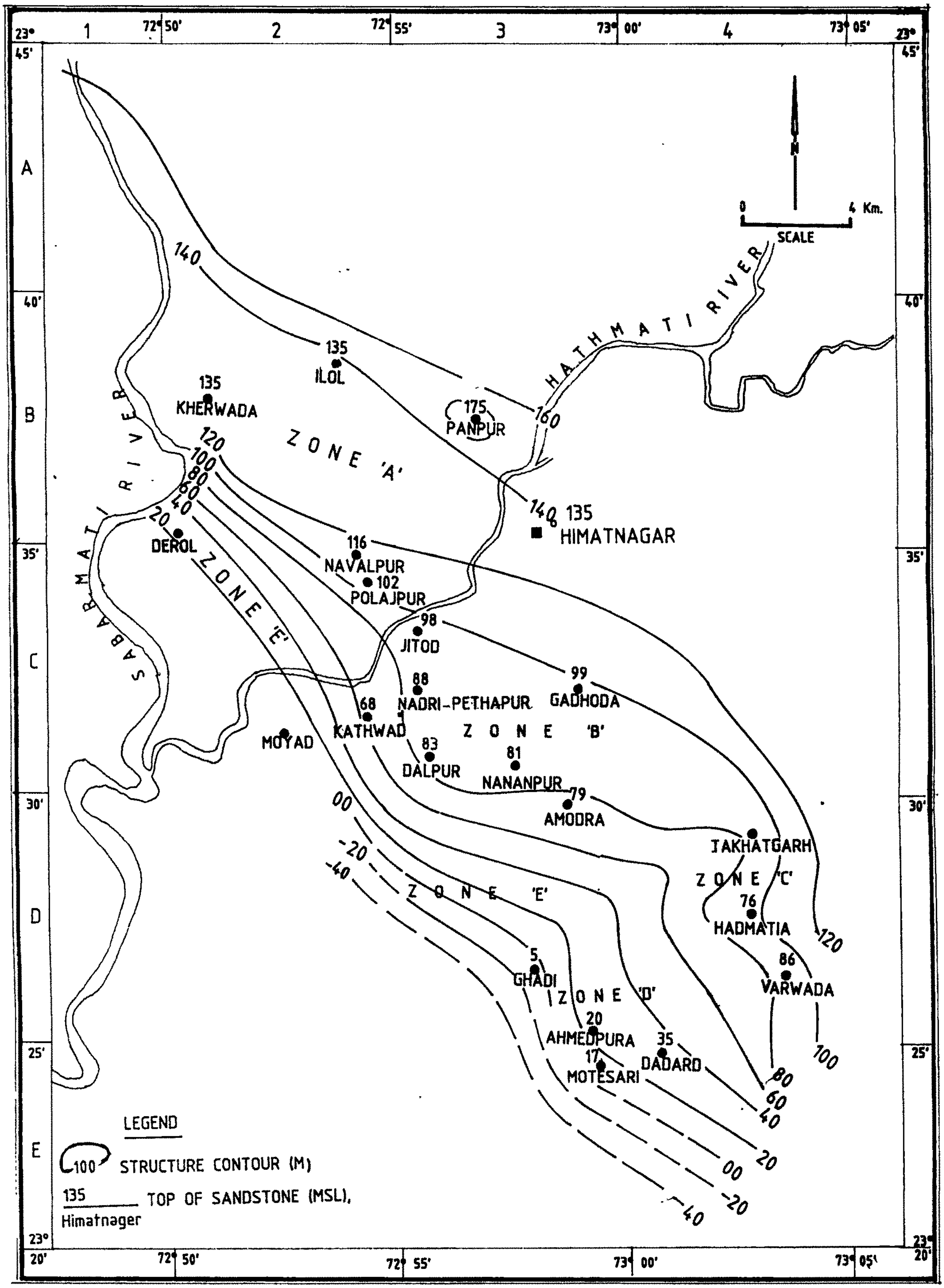


FIG. VI 4 STRUCTURE CONTOUR MAP ON TOP OF HIMATNAGAR SANDSTONE

Zone C

This zone characterises the Dharwar trend having a level difference from 125 m (Mohanpur) to 86 m (Varwada) suggesting a possibility of a fault with southwestern downthrow side.

Zide D

This zone delineates a small southwestward sloping terraces lying between 17m (Motesari) and 35 m (Dadard).

Zone E

This zone is showing NNW-SSE trend with closely spaced structure contours suggesting a fault with southwestern downthrow. Thus the structure contour map on top of Himatnagar sandstones suggest step faults with downthrow due southwest.

(C) **Deccan Traps**

This structure contour map on top of Deccan Trap does not show significant alignment of contours like previous two maps (Fig. VI.5). However, on the basis of contour characteristics, the map has been described into four zones.

Zone A

In this zone the trap occurs between 90-118 m (MSL), below 5 to 25 m alluvium. The structure contours do not show any particular basement grain.

Zone B

In this area the closeness of contours between Motesari (90m) & Umedni Muvadi (35m), as also between Motesari (90m) &

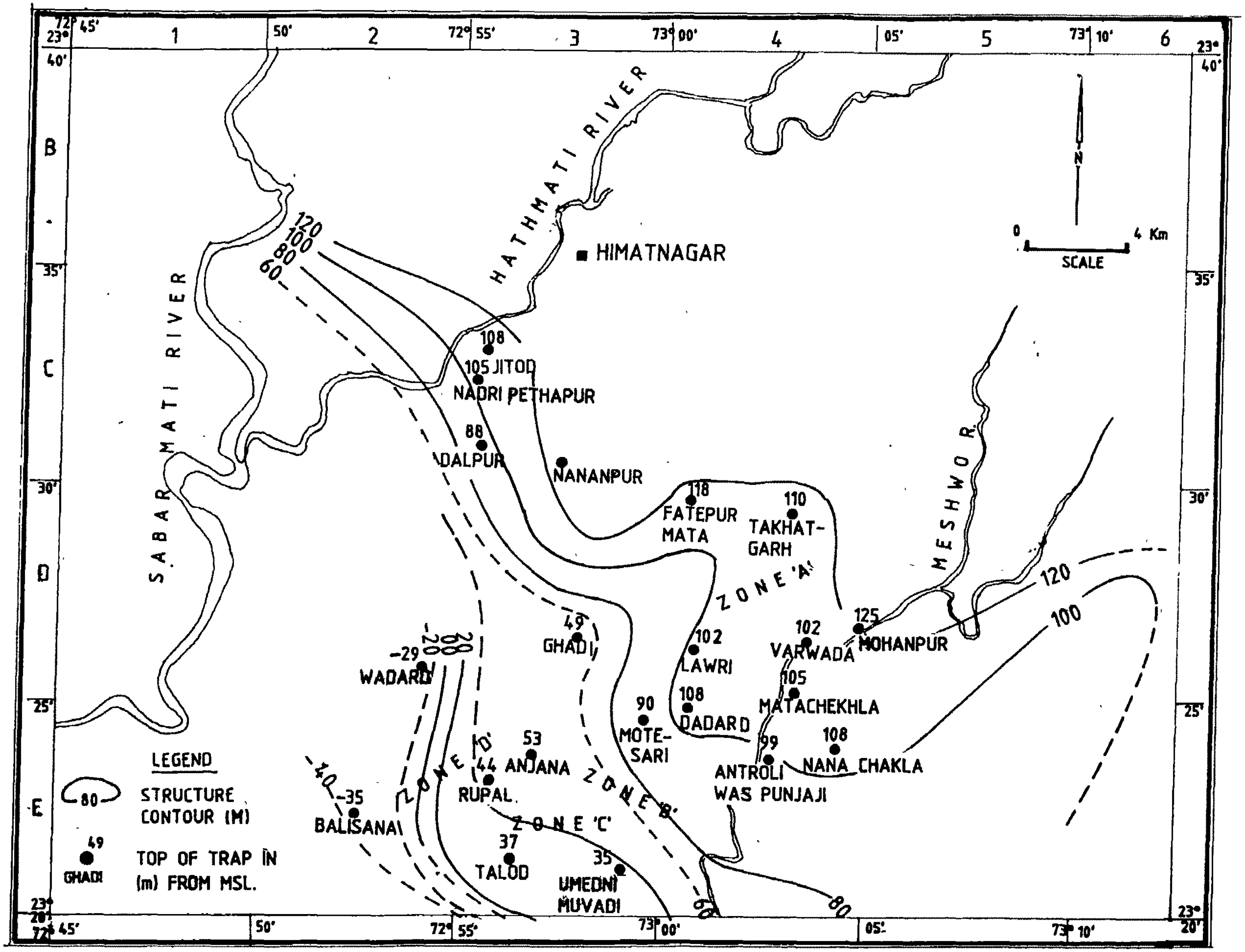


FIG. VI 5 STRUCTURE CONTOUR MAP ON TOP OF DECCAN TRAP.

Ghadi (49m) suggests a possibility of a fault with southwestward downthrow.

Zone C

This area forms a more or less terrace like feature between 35 m and 53 m (MSL) in the vicinity of Umedni Muvadi, Rupal, Ghadi etc and does not continue northwards; perhaps they might have been by affected by cross faulting.

Zone D

In this zone also the contours are relatively close due to sharp difference in altitude between Rupal (44 m) and Balisana (-35m) indicating a marked faulting with a general westward downthrow.

ii) **Isopach maps**

The isopach maps of Deccan Traps and Himatnagar sandstones have given good understanding on the depositional environments and tectonic framework of the Himatnagar area.

a) **Deccan Traps**

The isopach map (Fig. VI.6) prepared for Deccan trap formation has a general NNW-SSE trend with local swing parallel to NE-SW direction along Jitod-Mayad and also Takhatgarh-Lawri areas. The map clearly indicates that the thickness of basaltic rocks is very less (< 20m) in NE and shows a sudden increase in thickness (> 50m) in southwestern direction suggesting the faulting with southwestward throw after some initial accumulation of lavas along NNW-SSE Dharwar trend.

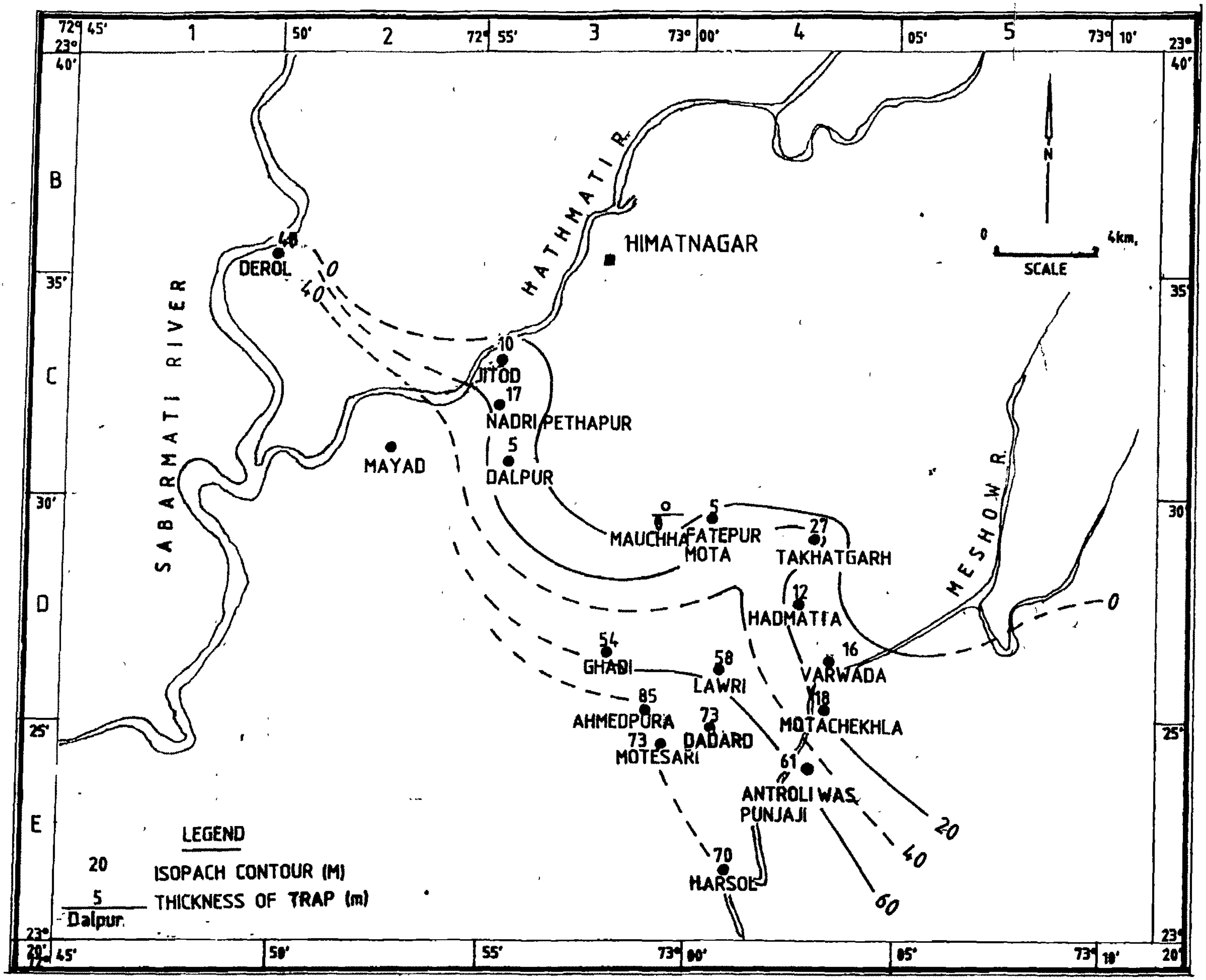


FIG. VI 6 ISOPACH MAP OF DECCAN TRAP.

(b) **Himatnagar Sandstones**

The isopach map (Fig. VI.7) shows the following characteristics :

i) The thickness of sandstones near village Ilol is 60m, just 3 km away NE to this at Kanai the sandstones suddenly disappear and only granites are seen. This sudden increase in thickness of sandstones at Ilol perhaps is due to synsedimentary fault in the basin.

ii) In the area W of Himatnagar the thickness of sandstone is more than 110 m suggesting the principal depositional area mainly in E-W alignment. Further north and south the thickness decreases indicating their deposition on the flank of the basin. The E-W orientation of the isopach contours suggests the extension of these sandstones further west. These sediments might have been deposited by Hathmati river.

iii) Again in the vicinity of village Ghadi, the thickness of sandstone is more than 95 m. The thickness decreases towards north and south. The sandstones seem to continue in the west. This perhaps suggests another centre of depositional basin developed by Meshwo river.

iv) The reduction of the thickness of sandstones along Katwad-Dalpur, Fatepur Mata and Takhatgarh alignment clearly suggests that the Hathmati basin and Meshwo basin are separated by a relatively 'high' intervening area forming the southern flank of Hathmati basin and northern flank of Meshwo basin with E-W axis.

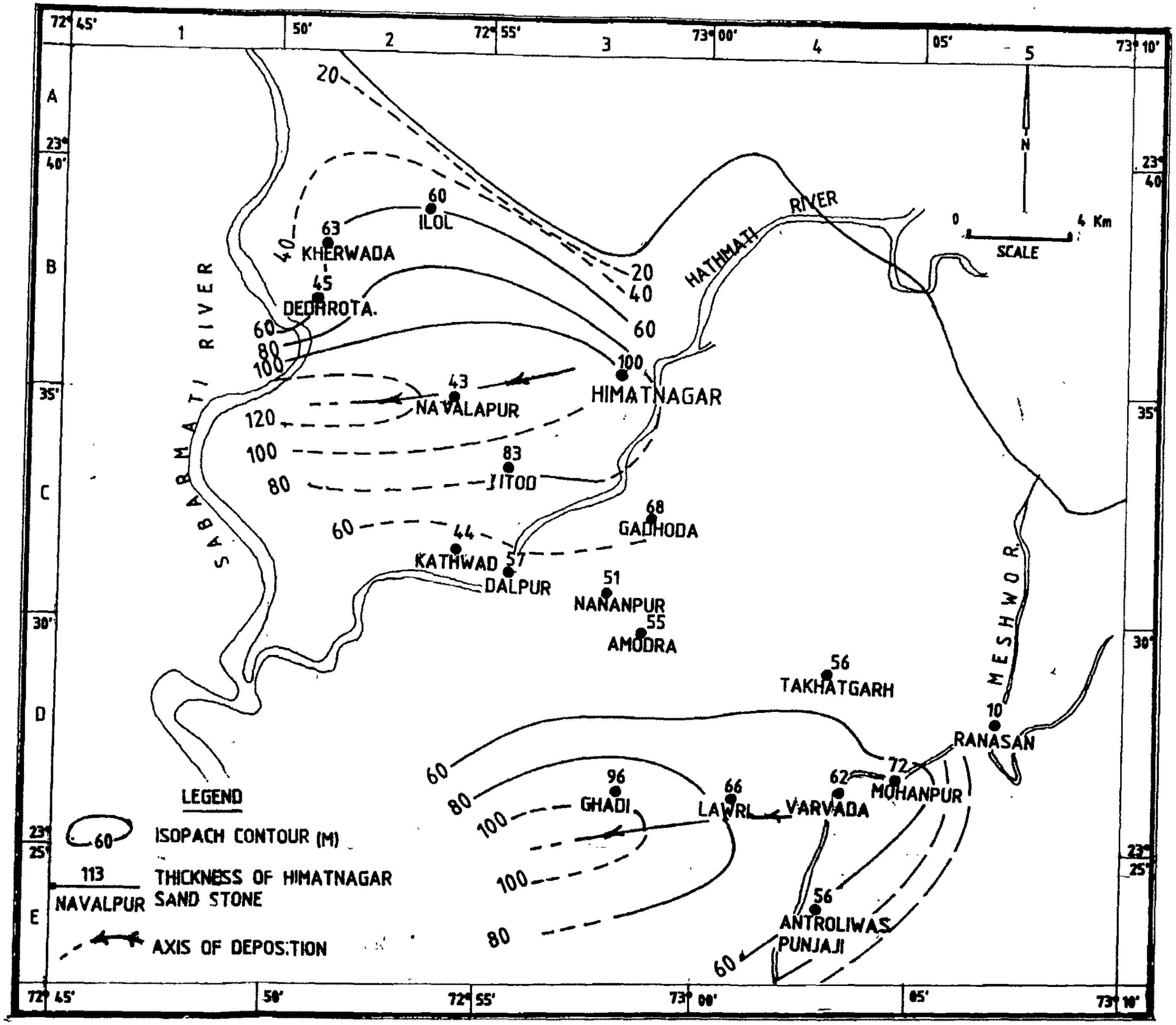


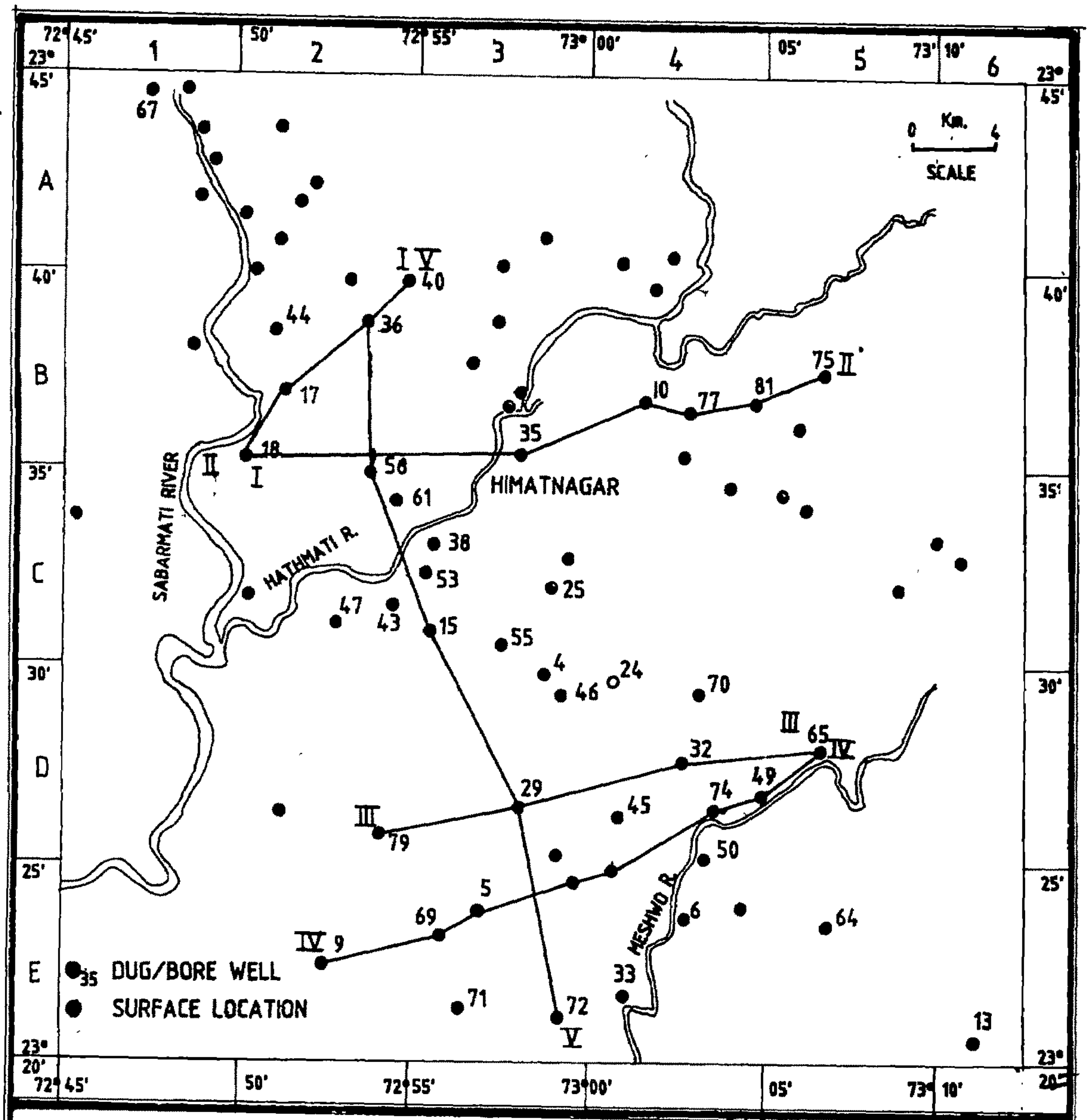
FIG. VI. 7 ISOPACH MAP OF HIMATNAGAR SANDSTONE

c) **Geological Sections**

In order to visualise a better picture of the behaviour of the various litho-units due to the role played by deposition, tectonism and erosion, the author has drawn four E-W and one N-S cross section (Fig. VI.8). These sections were drawn mainly on the basis of the sub-surface and also surface data for various geological units viz. Erinpura granites, Himatnagar sandstones, Deccan Traps and Alluvium.

(a) **Section from Derol to Kanai**

In the section (Fig. VI.8) at Kanai the granites are exposed while at the Ilol the granites undelie the Himatnagar sandstones at 79m (MSL) and capped by a thin layer of alluvium. At Derol the sandstones are met at 27 m (MSL) and extend further down below - 73 m (MSL); the base of which is not encountered. The sandstones are overlain by Deccan trap (48 m thick) and alluvium (47 m). The level difference of 65 m of granites between Kanai and Ilol and total absence of sandstones near Kanai suggests a possibility of synsedimentary fault. Again between Dedhrota and Derol, the levels of sandstones show a marked difference of about 100 m as also the absence of Deccan Trap at Dedhrota suggests a clear cut indication of faulting with SW downthrow. This section further reveals the limits of Deccan Trap between Derol and Dedhrota and limit of sandstone between Ilol and Kanai villages.



SECTIONS

I	DEROL (18) TO KANAI (40)
II	DEROL (18) TO VAVDI (75)
III	WADARD (79) TO RANASAN (65)
IV	BALISANA (9) TO RANASAN (65)
V.	UMEDNI MUVADI (72) TO KANAI (40)

FIG VI 8 MAP SHOWING SUBSURFACE GEOLOGICAL SECTIONS

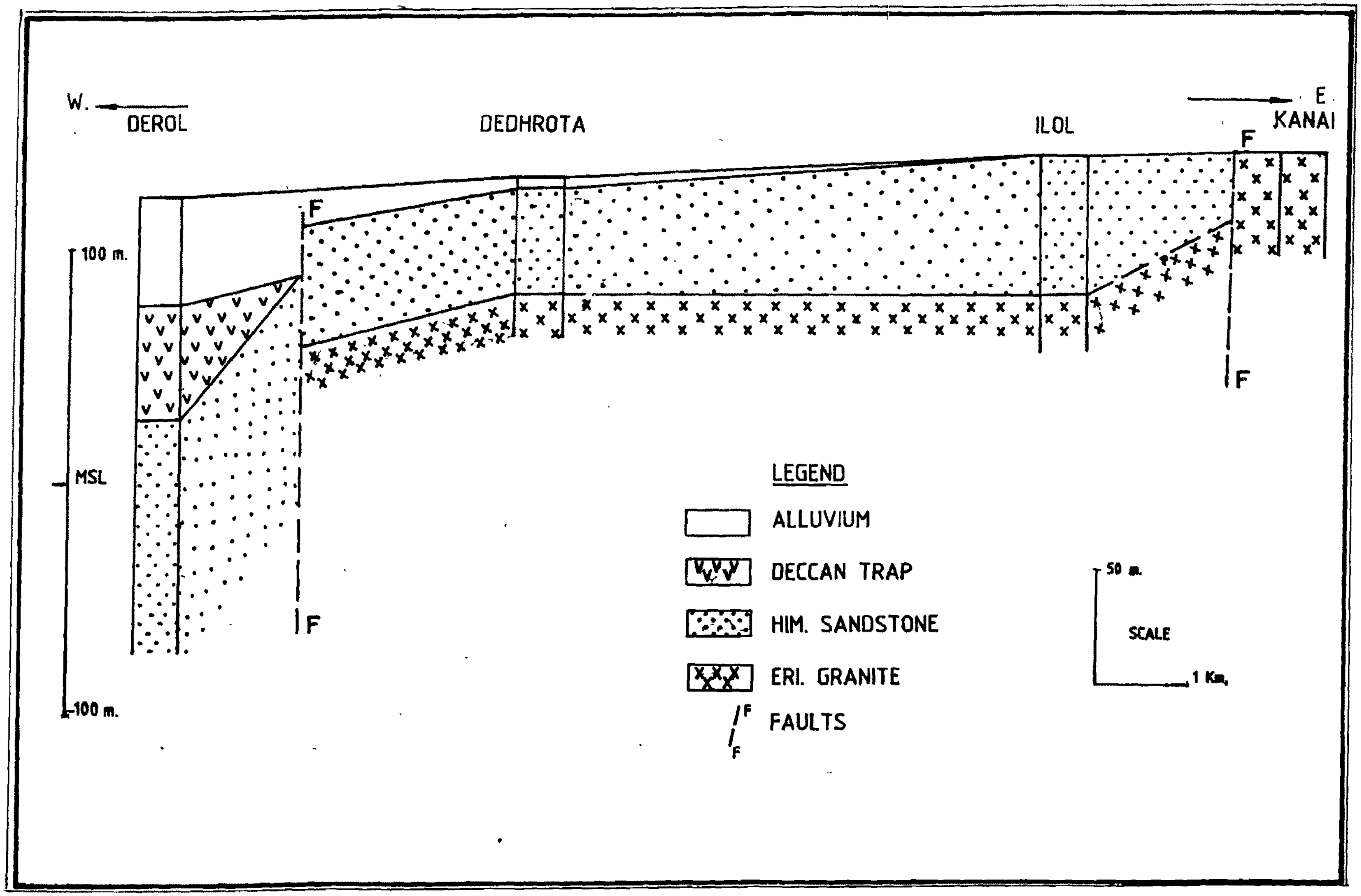


FIG VI 9 SUB SURFACE GEOLOGICAL SECTION FROM DEROL TO KANAI.

(b) **Section From Derol to Vavdi**

This section (Fig. VI.10) is conspicuous in the way that it comprises the flat topped sandstones lying on the granite hills, those of low lying terrain and sub surface area. At Wantra 40 m horizotally bedded sandstones overlie the flat-topped Erinpura granites at about 200 m (MSL) while at Berna they rest on granites at 170 m with the same thickness. Low lying terrain near Hamirgarh, Virawada, Gamdi, Himatnagar the ground is almost peneplained with horizontal sandstone occurrence; the slope being gradual towards west (160 m to 140 m MSL). This 30 m elevation difference between Wantra and Berna could be due to faulting. The occurrence of granites at 40 m (MSL) depth below sandstones at Himatnagar clearly suggests downward faulting of western block. At Derol the top of sandstones is encountered at 27 m as mentioned in Kanai-Derol section. It is also seen that there is a progressive westward increase in the thickness of sandstones. Considering the overall picture, it is clearly seen that the area has experienced the step faulting with southwestward downthrow. East of Wantra marks the limit of Himatnagar sandstones and the Erinpura granites.

(c) **Section From Vadard to Ranasan**

In this section (Fig. VI.11) only at Ranasan in the ENE the surface exposures of Himatnagar sandstones are seen while tracing toward WSW, little beyond Ghadi village, the sandstones occur below the trappean rocks. The thickness of the alluvial cover, trap rocks and sandstones increases westwards with major breaks

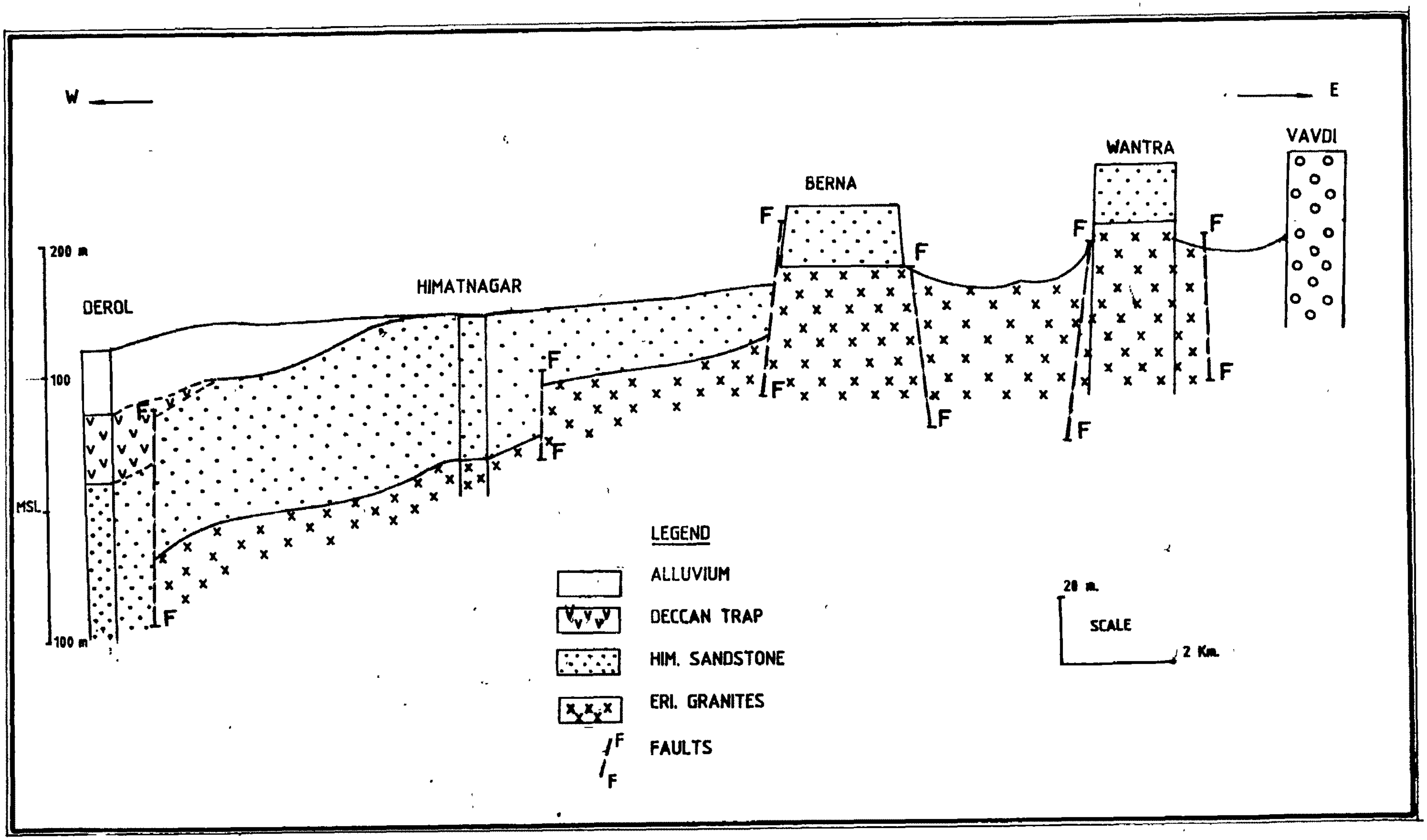


FIG VI 10 SUB SURFACE GEOLOGICAL SECTION FROM DEROL TO VAVDI.

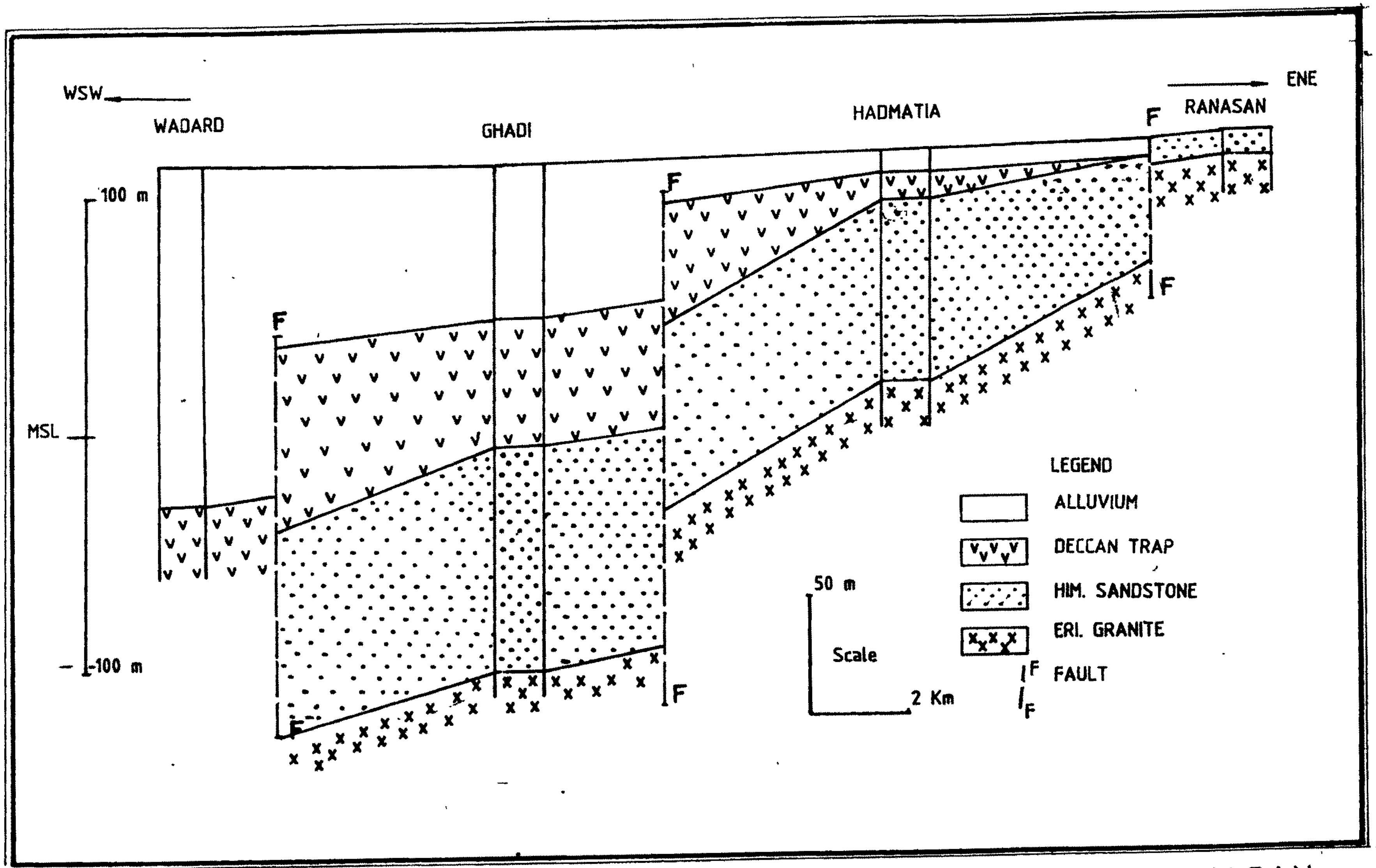


FIG VI 11. SUB SURFACE GEOLOGICAL SECTION FROM WADARD TO RANASAN indicating evidencing the step faulting with sourthwestern downthrow.

(d) **<u>Section from Balisana to Ranasan</u>**

This section (Fig. VI.12) is identical to the Wadard-Ranasan section (Fig. VI.11) where step faulting is clearly recognised. At Mohanpur the contact between sandstones and Deccan traps is also clearly visualised.

(e) **<u>Section from Umedni Muvadi to Kanai</u>**

This is a more or less NS section (Fig. VI.13). The surface exposures of Ilol are extending below alluvium southward. The thickness of Deccan Trap as also of alluvium increases from Dalpur towards Talod. The conspicous character of the section is that it shows maximum thickness of sandstones at Navalpur and Ghadi which decreases on either sides. The dominance of thickness suggests the main axis or principal axis of deposition by two separate agencies. It is worth while to mention here that these two areas form the core of depositional basins of Hathmati and Meshwo rivers.

Discussion

The field studies of the sandstones lying on the flat topped elevated granitic hills of Ghorwada, Wantra and Berna and also the faulted contact between sandstones and traps near Mohanpur suggests that the Himatnagar area has experienced a tectonism after the deposition of the sandstones. As again the structure

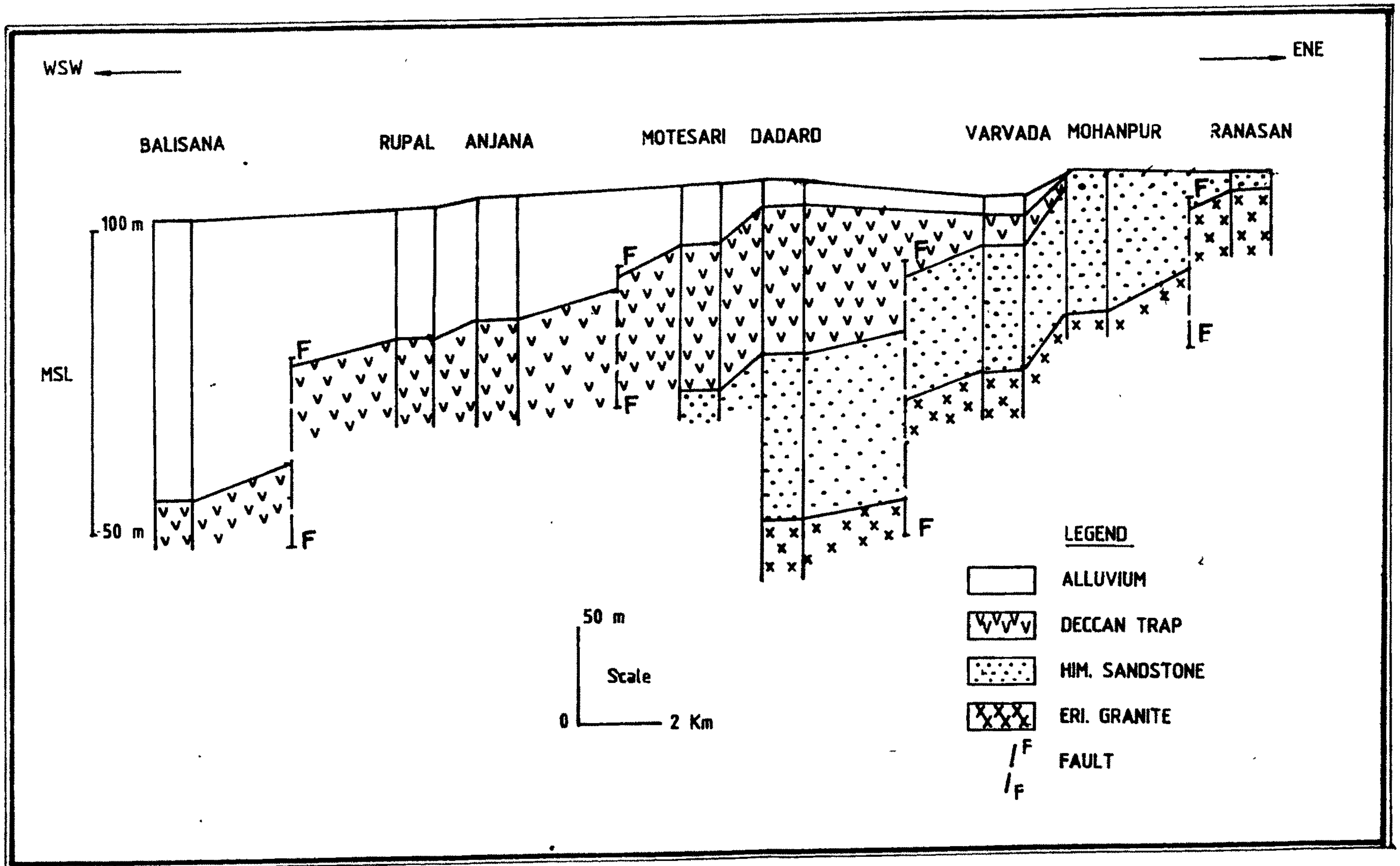


FIG VI 12 SUB SURFACE GEOLOGICAL SECTION FROM BALISANA TO RANASAN

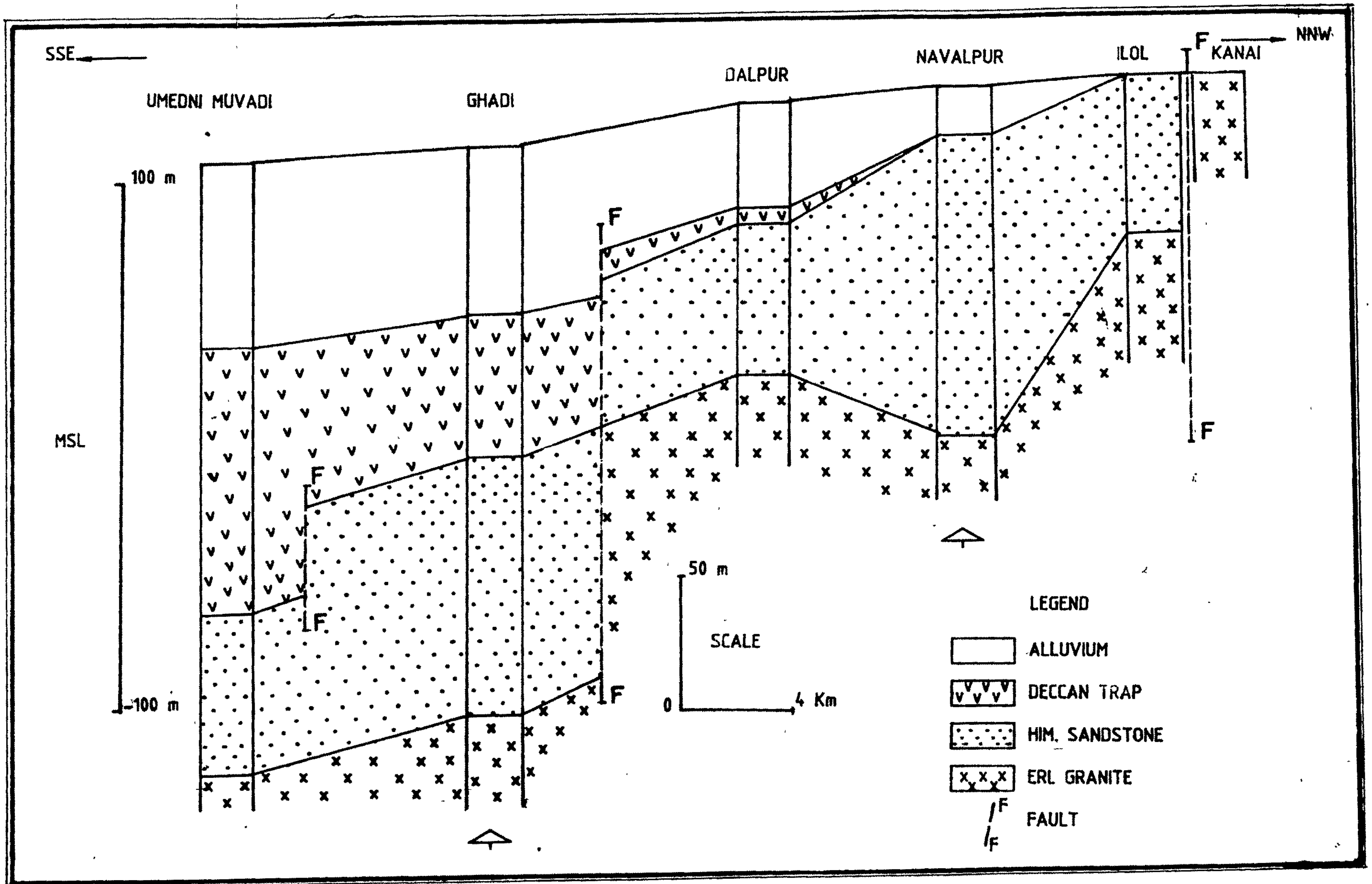


FIG VI 13 SUB SURFACE GEOLOGICAL SECTION FROM UMEDNI MUVADI TO KANAI contour maps, isopach maps together with geological cross sections across the various litho-units in the sub-surface area clearly reveal that the deposition of Himatnagar sandstone is fluvial environment in atleast two parallel basins of the river Hathmati and Meshwo; elogation of the basin being almost E-W. The subsequent tectonic activities is responsible to give rise to numerous step faults with sothwestern downthrow striking parallel to NNE-SSW Dharwar trend with cross faults parallel to NE-SW Aravalli-Delhi and ENE-WSW Satpura trends.

It is worthwhile to mention that to the west of study area in Saurashtra, the Dhrangadhra sandstones were also deposited over Pre-Cambrian basement during Early Cretaceous period. Further in the northern part of Cambay Basin below the cap of alluvium, the fluvial sandstones have been reported between Deccan Trap (Upper Cretaceous) and Pre-Cambrian basement.

Dharangadhra sandstones contain mostly sub rounded quartz with unimodal westerly dips, the provenance being Aravallis/ Delhis and Erinpura granites from east, across Cambay Basin (Bhandari & Suresh kumar 1970). Lithologically, they are similar to Himatnagar sandstones i.e. mainly quartz arenite with impoverishment of felspars. Their deposition is under fluvial to deltaic environments (Shrivastava, 1973; Biswas, 1982, 1983, 1987; Aslam & Casshyap,(1985) and palynological studies assign the Early-Cretaceous age to these sandstones (Verma & Rawat, 1964; Venkatchala & Rawat, 1970).

The sub-surface data of the northern part of Cambay Basin confirms the presence of sandstones below Deccan Trap (Upper Cretaceous). They were deposited in the continental environment (Desikachar, 1971; Mukherjee, 1983) with the provenance from east i.e. the metamorphic rocks of Aravallis/Delhis and Erinpura granites (Hardas, 1980). These sandstones of Cambay basin are older than Deccan Traps and are lithologically similar to Himatnagar and Dhrangadhra sandstones. All these occurrences, when considered in relation to the regional tectonic framework of NW India during Early-Cretaceous, have led the author to envisage the deposition of the sandstones of all the three basins on a common platform during Early-Cretaceous period.