CHAPTER - IV

THE CAMBAY BASIN

The Cambay basin, one of the major petroliferous basins of India, is located on the Western margin of the Indian plate and covers an approximate area of 56,000 sq km. Geophysical exploration of this basin for petroleum prospects have resulted in a wealth of data with respect to its tectonics and depositional history, during Tertiary in particular. The Tertiary stratigraphy and structural styles have been worked out by several authors (Mathur et al., 1968; Zubov et al., 1966; Raju, 1968, 1979, 1983; Markevich 1976; Biswas, 1982, 1987). Deep Seismic Sounding surveys have also contributed significantly in understanding the crustal anomalies and basin floor structure (Kalia et al., 1980, 1981, 1990; Tiwari et al., 1991, 1995).

The Cambay basin is a narrow NNW-SSE trending rift graben extending from north Gujarat to south Gujarat (Fig. 4.1). Presently the graben lies buried below a considerable thickness of Quaternary alluvial sediments. The Cambay graben is bounded by the Aravalli orogenic belt in the NE and by the Deccan plateau in the east and in the west by the Saurashtra horst. Towards the south, the basin joins the Surat depression, the Bhavnagar-Aliabet arch. Surface exposures of Precambrian and Mesozoic rocks occur in isolated localities on either sides of the basin.

The Cambay graben is one of the three major marginal rift basins in the western margin of the Indian craton which developed subsequently from north to south during India's drift after the break-up of the Gondwanaland (Biswas, 1982). Within the Cambay basin, the Deccan basalts form the basin floor over which Cenozoic sediments were deposited. The combined thickness of the Quaternary and Tertiary sediments in most parts of the basin varies between 3000 and 5500 m. Some deep wells located in the southern part of the basin have reached the trappean basement. Roy (1991) has discussed three deep wells in this part of the basin (Fig. 4.2). Of these, Well A reached the Archaean basement after penetrating 518 m of Quaternary, 865 m of Tertiary 1550 m of Deccan trap and 130 m of Cretaceous (Fig. 4.2).

The outpouring of the Deccan basalts around 65 m.y. coincides with close of Cretaceous and advent of Tertiary (Subbarao, 1988). The age of Deccan basalts has

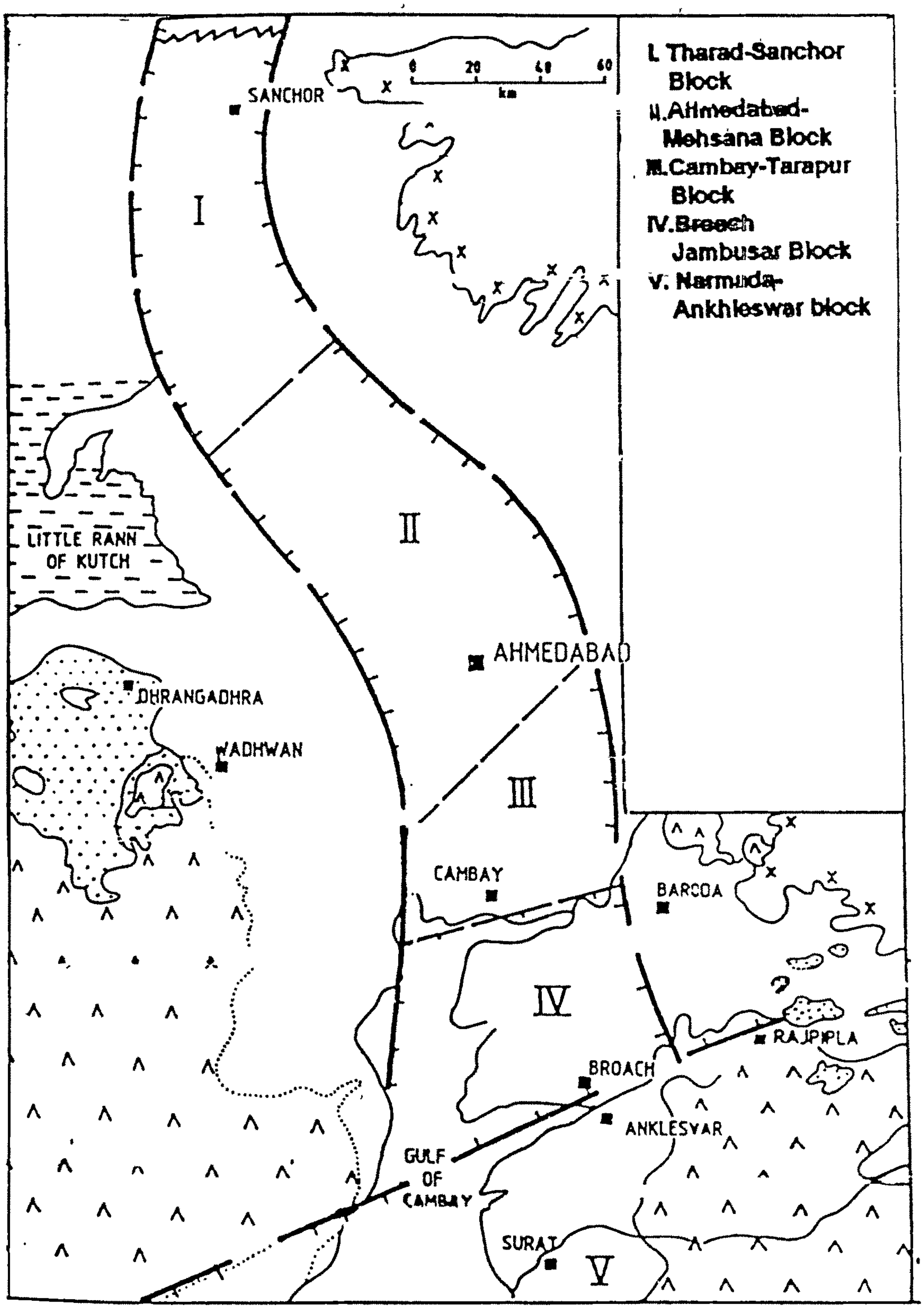

Fig. 4.1 Tectonic map of Cambay basin (after ONGC)

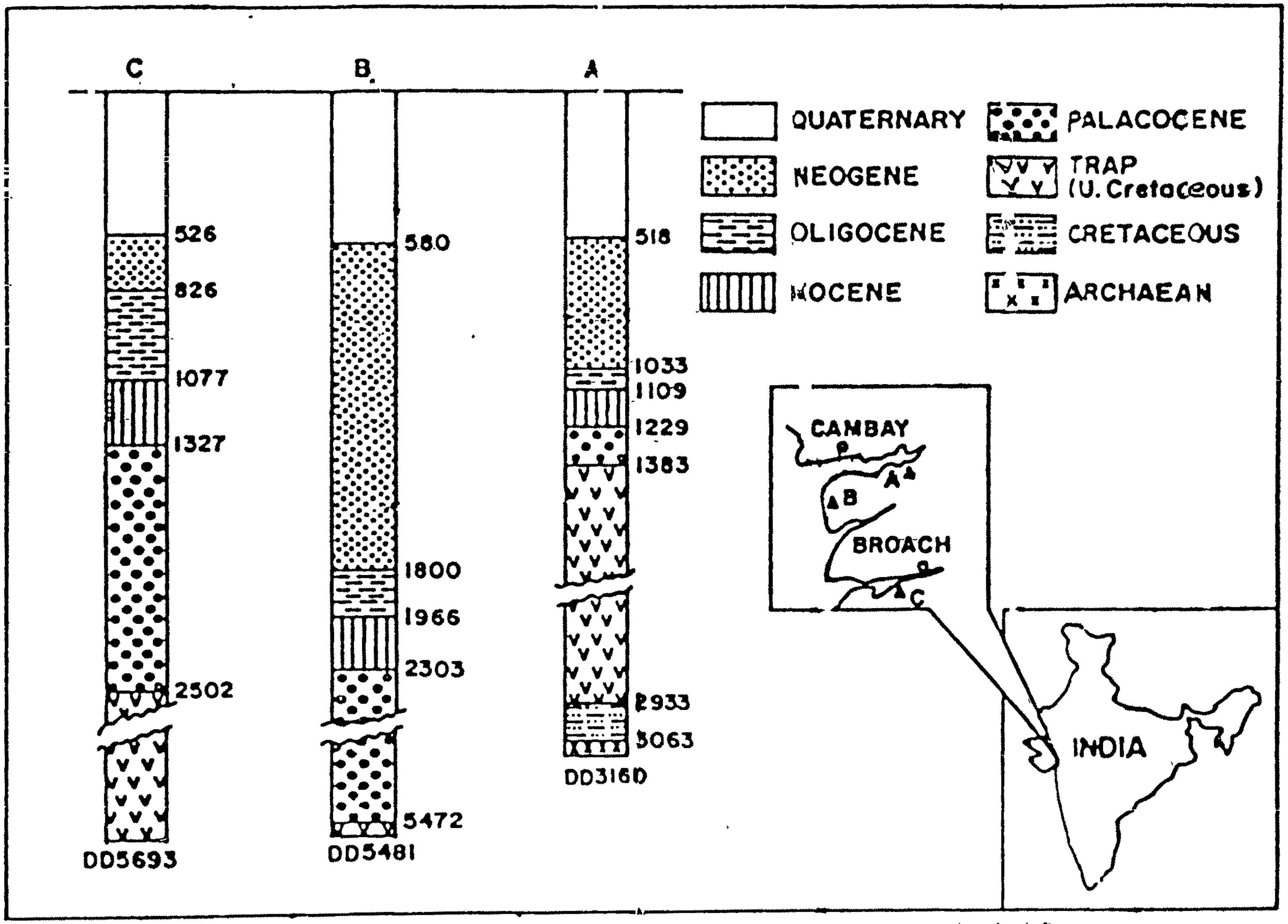

Fig. 4.2 Borehole geology of three deep wells in the Cambay basin (after

Roy,1991)

been estimated as 69-64 ma (Venkatesan et al., 1986). According to Courtillot and Ciswoski, 1987), the bulk of the Deccan basalts were extruded in only 0.5 my (main age 66 ma). The presence of Deccan Trap through out the basin and the mantle updoming in the Gulf of Cambay (Arora and Reddy, 1991) is represented by high thermal values (Biswas, 1987). The high Bouger anomaly values in the basin have been attributed to various factors like Moho upwarp (Negi, 1951), large thickness of volcanics in the basin (Kailasam and Qureshi, 1964; Rao, 1968) or upper mantle intrusion in the upper crust (Verma et al. 1968). Based on the results of crustal seismics, Tewari et al. (1991) attributed the gravity high comparable to that in the Aravallis (Fig. 4.3), to large volcanic thickness and Moho upwarp accompanied by high density lower crust.

The major tectonic process during the Tertiary was subsidence which is evidenced by the large thickness of these sediments (maximum 4000 m) as shown by Kalia (1990). Sedimentation pattern and the palaeogeography of the Cambay basin during the Tertiary has been worked out in great detail by the workers of ONGC (Table 4.1). These studies suggest that the basin repeatedly suffered transgressive and regressive conditions. The tectonic movement within the Cambay basin during the Tertiary have been equated with the three major phases of Himalayan uplift in the corresponding period (Biswas, 1987).

The block structure of the basin controlled by basement faults has been clearly brought by Mathur et al. (1968). Raju (1969) related the development of India as a sequel to sea floor spreading discussed at length by Biswas (1982, 1987). The steep

AREA / AGE	SURFACE	SUB SURFACE					SURFACE
	WESTERN MARGIN	THARAD	AHMEDABAD MEHSANA	TARAPUR	BROACH	NARMADA	EASTERN MARGIN
RECENT TO PLEISTOCENE	ALLUVIUM	GUJARAT ALLUVIUM					ALLUVIUM
	AGATE CONGL.	BUDHANPUR FORMATION	JAMBUSAR FORMATION				
PLIOCENE			BROACH FORMATION				
U. MIOCENE	PIRAM BEDS	ANTROL FORMATION	JAGADIA FORMATION				
M. MIOCENE	KUDA BHUMBALI	DHIMA FORMATION	KAND FORMATION				
L. MIOCENE	RATANPUR	DEODAR FORMATION	BABAGURU FORMATION				
			TARKESHWAR FORMATION				
OLIGOCENE			TARAPUR SHALE		DADHAR FORMATION		
U. EOCENE		WAY FORMATION			ANKLESVAR FORMATION	TELWA SH. ARDOL MBR. KANWA SH.	NUMMULITICS
M. EOCENE		THARAD FORMATION	KALOL FORMATION	VASO FORMATION	ANKLESVAR FORMATION	HAJAD MBR. HAZIRA SHALE	
L. EOCENE			KADI FORMATION	UPPER CAMBAY SHALE		HAZIRA SHALE	
PALEOCENE	LATERITIC ROCKS	BALUTRI FORMATION	LOWER CAMBAY SHALE VAGAD KHOL FORMATION				
UPPER CRETACEOUS	DECCAN TRAP GROUP						
L. CRETACEOUS TO JURASSIC	MESOZOIC SEDIMENTS						
ARCHAEAN	GRANITE						

Table 4.1 Stratigraphy of Cambay basin (after Sastry et al., 1984)

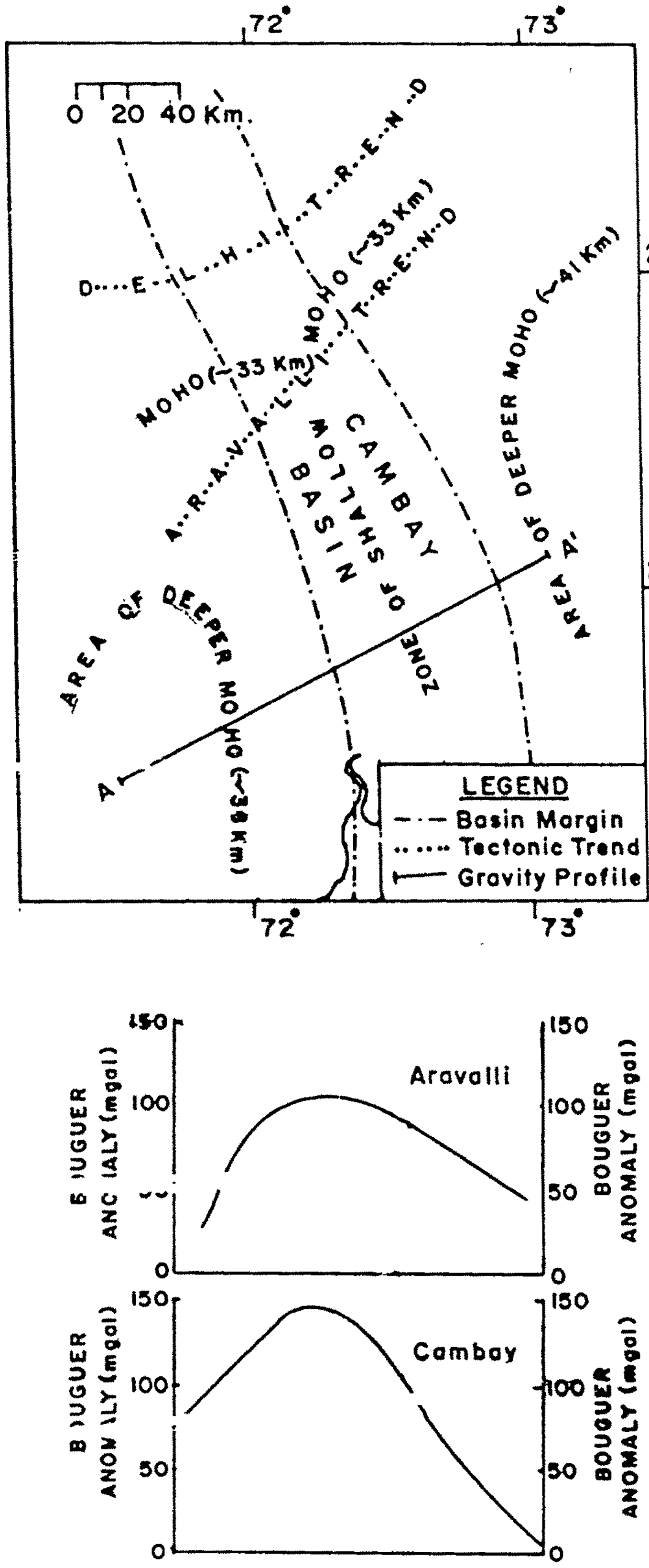

Fig. 4.3 Figure showing comparative gravity anomalies in Cambay basin and Aravallis (after Tewari et al., 1991)

enechelon boundary faults delimiting the basin width, simultaneous shoulder uplift of the basin with concomitant sedimentation and transverse block structure are some of the major features of the basin (Raju and Srinivasan, 1983). The architecture of the basin seems to be controlled by three Precambrian orogenic trends. The Satpura trend parallels the ENE-WSW Narmada-Son lineament which is the major tectonic boundary (West, 1962, Chaubey, 1971). The NE-SW Aravalli trend continues across the Cambay basin while the Delhi trend swings E-W producing a series of step faults (Kalia et al., 1990). The third trend NNW-SSE swings eastward and merges with the ENE-WSW Precambrian trend (Biswas and Deshpande, 1983). Mathur et al. (1968) divided the basin into four morphotectonic blocks based on cross lineaments (Ankhleshwar, Broach, Tarapur and Mehsana). The cross faults indicate continuation of Aravalli-Delhi trend across the basin. Subsequently Markevich (1976) identified two more tectonic blocks (Tharad and Sanchor) in northern parts of the basin. Seismic, CDP, DSS data (Fig. 4.4 and 4.5) confirm the presence of such blocks (Kaila, 1980, 1990).

Based on structural styles such as fault pattern , symmetry, size and orientation of the depressions, these have been regrouped into five structural blocks from north to south.

1. Tharad-Sanchor Block
2. Ahmedabad-Mehsana Block
3. Cambay-Tarapur Block
4. Broach-Jambusar Block

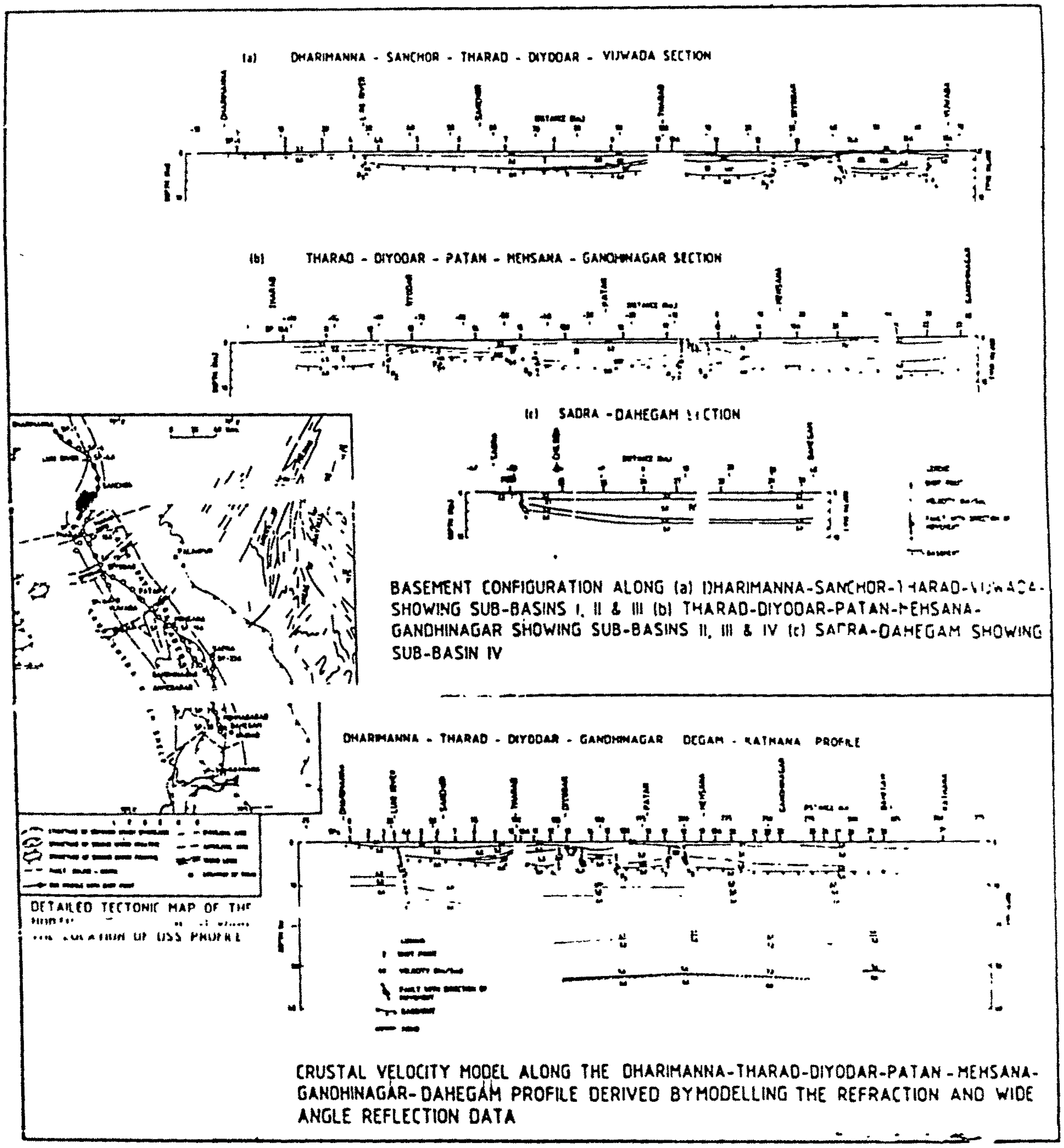

Fig. 4.4 Basement configuration based on DSS studies in north Cambay basin

(after Kaila et al., 1990)

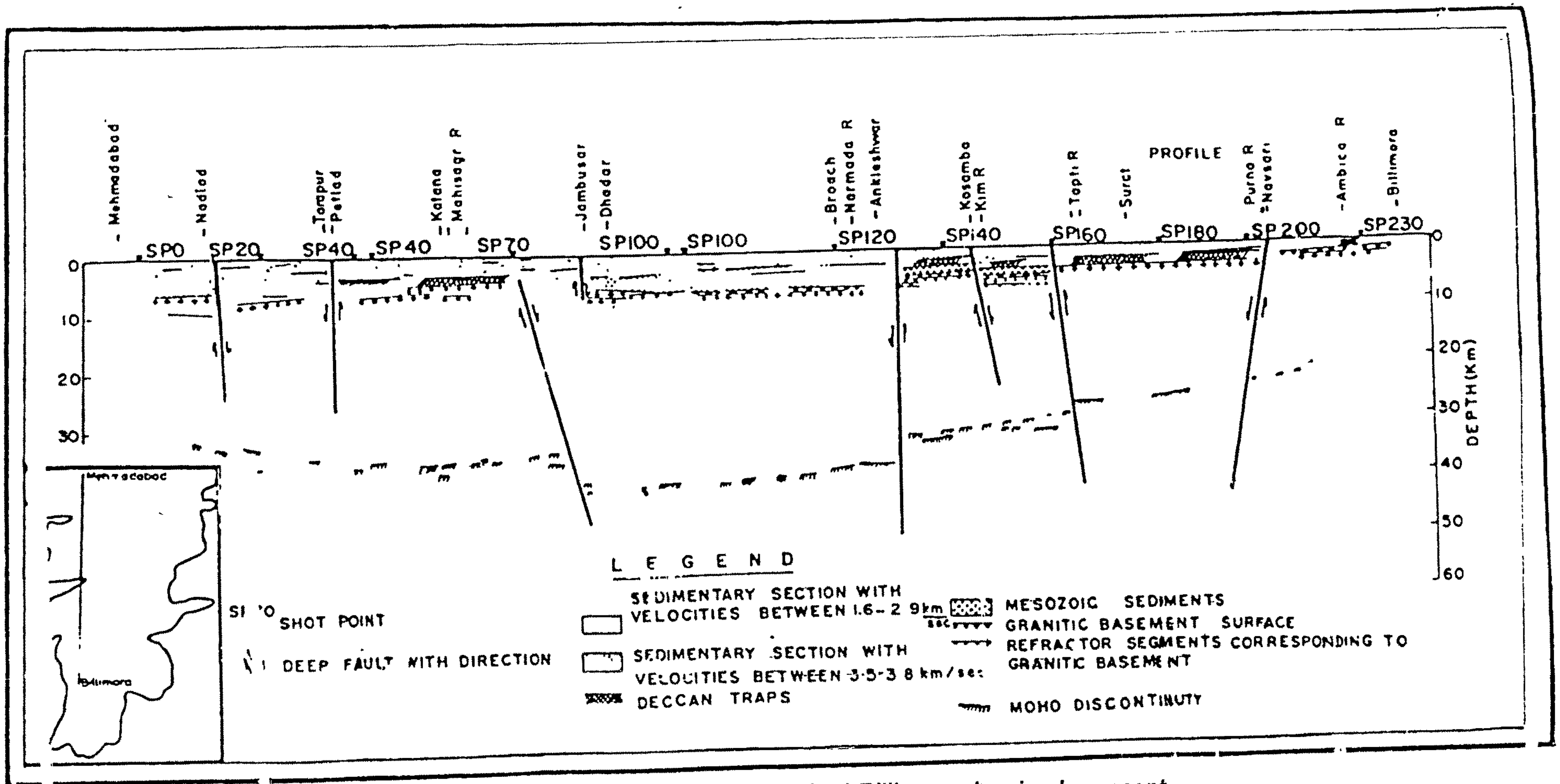

Fig. 4 5 DSS profile across Mehmadabad-Billimora showing basement configuration (after Kaila et al., 1981)

5. Narmada-Ankhleswar block

1. Tharad-Sanchor Block

This block lies between the Sanchor in the north and Khari river in the south. The entire sedimentary succession overlying the Deccan traps in this block is marine, except a small thickness of continental origin of Tarapur shelf of late Eocene-Early Oligocene age (Roychowdhary et al., 1972). DSS studies (Kaila et al., 1990) helped in delineating three subbasins namely, the north Sanchor basin, the south Sanchor basin and the Patan basin. The north Sanchor basin starts south of Luni river. The second subbasin which is separated from the first by a ridge structure near the Tharad is possibly a southern extention of the Sanchor basin. The Tharad ridge is thus more likely to represent a basement high within the Sanchor basin. The Patan subbasin is separated by the Diyodar ridge and continues upto the Unhawa ridge. The basement is moderately faulted in the northern part but a criss-cross fault system develops very profoundly between Tharad and Patan where the Deccan trap surface is considerably irregular.

2. Ahmedabad-Mehsana Block:

This block lies between Khari river in the north to the Vatrak river in the South. Area wise this block is the largest extending upto the Unhawa ridge in the north. This block includes the N-S trending features . The Mehsana horst which divides the basin into eastern and western depressions. The marginal faults are more pronounced in this block than in the other blocks.

3.Cambay-Tarapur Block :

This block is bounded in the south by the Mahisagar fault and in the north by a transverse fault extending NW-NE, close to the Sabarmati river and its tributary Meshwa. Both the northern and the southern boundary fault have their downthrow to the south, making the block a big tectonic step in the basin. The block consists of a syncline near Tarapur and two anticlines on its SE and SW flanks; Cambay structure and Kathana structure (Mathur et al., 1968). The above folds are associated with the faults in the traps. Eastern margin of this block is marked by enechelon faults unlike that of Ahmedabad block where basin margin faults are clearly discernible.

4. Broach-Jambusar Block :

This block is bounded by the Mahisagar and the Narmada faults. It is characterized by a deep syncline in which maximum thickness of Cenozoic sediments have been deposited. The fault along the Mahi basin has been inferred from three main reasons (Mathur et al., 1968).

1. The difference of more than 1300 m in the depth of the Deccan trap on either sides of the Mahi river.
2. The westerly shift in the axis of deposition during Eocene along the Mahi river (downthrown block).
3. The strike swing of the Eocene sediments near Jambusar.

A fault at Atali and another to its southeast joins up with the main Mahisagar fault. The Atali fault with a downthrow of more than 200 m to the south. The eastern flank of this block is gentler than the western flank and is characterized by impersistent step faults. The depression is filled with thick almost 9 Km of Cretaceous to Quaternary sediments lying over the Archaean basement with intervening thick flows of Late Cretaceous to Palaeocene age.

The shift of the depocentre during Tertiary, from north to south gave it an asymmetrical shape. Large number of faults and associated structural highs mark the fringe areas of this depression. The fault in the northeast are oriented in NW-SE direction and in the northwestern flank they trend NE to SW approximately.

5. Narmada-Ankleshwar block :

This block lies to the south of Narmada river and is dominated by ENE-WSW trending structural elements. It is broadly an uplifted region containing a number of smaller blocks or slices which have undergone differential vertical movements (Roy, 1991). The sedimentary cover is relatively thin. The block tilts westward with gradual thickening of sedimentary layers and concurrent changes in the facies of the sediments. To the east along the fringe of the basin, the Tertiary rocks are exposed on the surface.