Chapter 2
Geological Information

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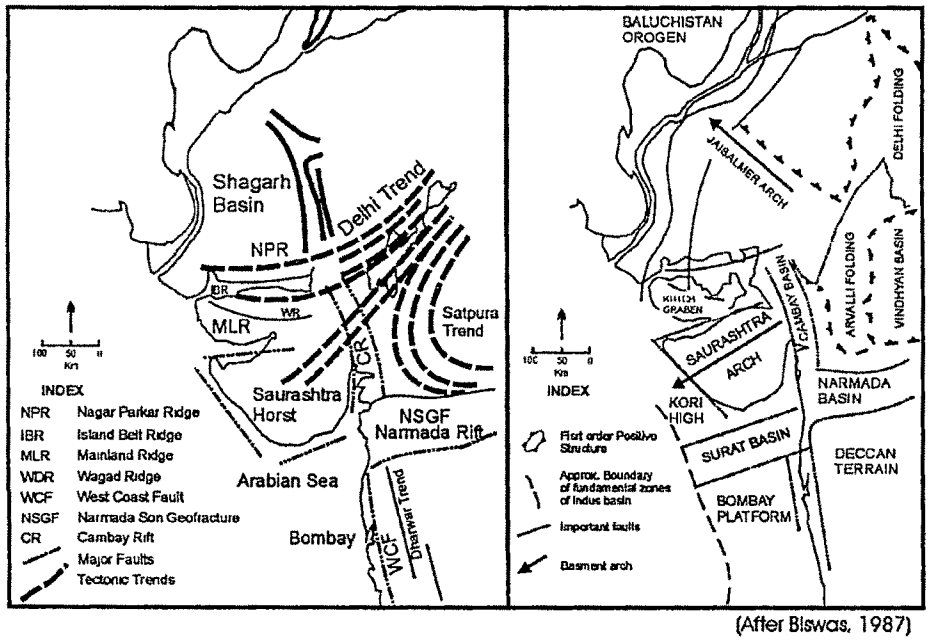
GEOLOGICAL INFORMATION

The study of geological setup and litho-tectonic environment of any area forms an essential component while dealing with a problem related to water resources utilization and its impact on physical as well as biological environment. It is a well established fact that an overall distribution of total water resources in any area is the manifestation of its geological attributes viz. nature and composition of lithologic and their lateral and vertical extent; structural and tectonic configuration; and geomorphic diversities. Hence, Looking to above described significance, the information on geological aspects of the study area, through available literature have been compiled and presented as under

REGIONAL TECTONIC FRAMEWORK



(After Biswas, 1987)

Fig. 2.1 Tectonic Setting of Western India

The study area MRBC forms a part of Central Gujarat Alluvial Plain and lies within the limits of Cambay Graben, a regional tectonic feature (Fig 2.1). The Cambay basin is situated on land and extending offshore into contiguous parts of Cambay shelf

and falls between the coordinates N21^0 to 24^0 & E71^0 30' to 73^0 30' E. It occupies an area of over 56,000 sq. km.

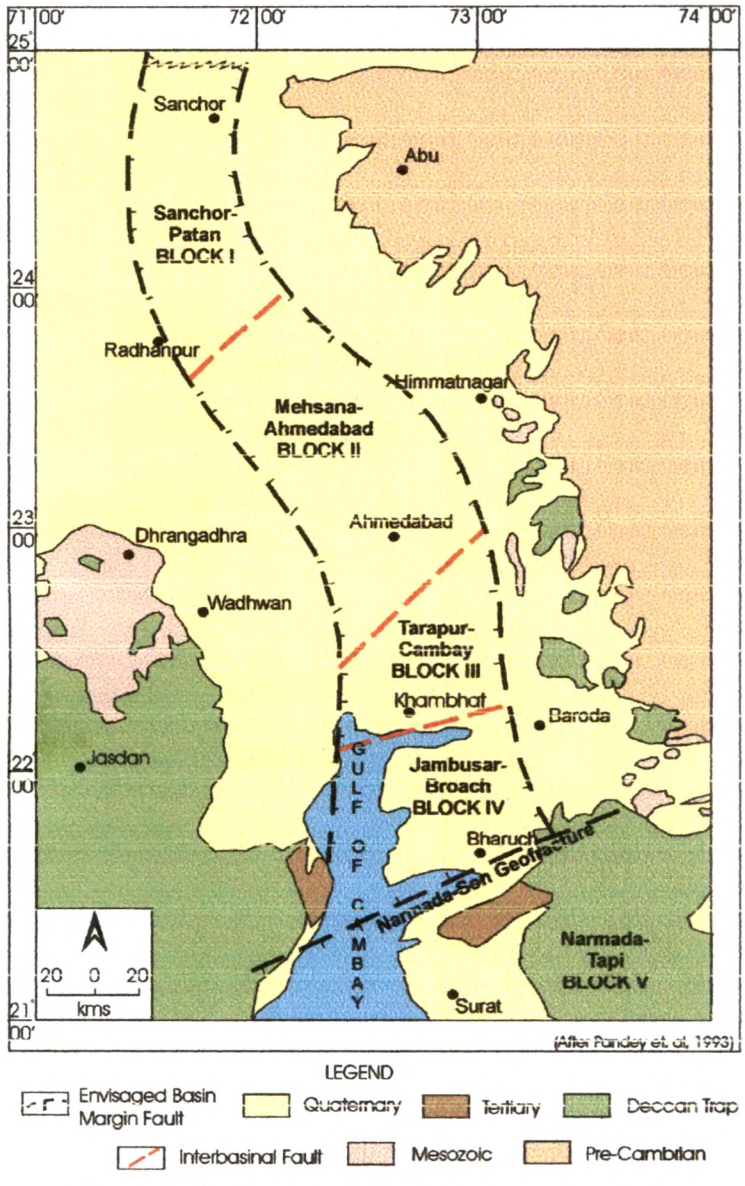


Fig. 2.2 Litho-stratigraphic Set-up of Cambay Basin

The tectonic aspects of the Cambay basin have been investigated by various workers from Oil & Natural Gas Corporation Ltd. (ONGC) viz. Raju, 1968; Mathur et.al, 1968; Chandra & Chowdhary, 1969; Rao, 1969; Biswas, 1987. The basin owes its

existence as an major outcome of major rift-drift phase of Mesozoic-Cenozoic times and occupying both onland and offshore areas along western margin and is described as intra-cratonic graben or half graben (Raju, 1968).

The basin in general is bordered by Saurashtra Craton in the west, Radhanpur-Barmer Arch in north, and Delhi-Aravalli orogenic bellt to the east and further bounded on either side by a system of en-ecchelon faults that parallel the Dharwarian NW to NNW structural trends (Fig. 2.1). Further, to the south in region of Narmada River series of the oblique faults parallel to the sub-latitudinal Satpura and NE-SW Aravalli trend, segmented the basin into five discrete tectonic blocks (Fig. 2.2) i. e. (I) Patan-Sanchore block, (II) Ahmedabad-Mehsana Block, (III) Tarapur-Cambay block, (IV) Jambusar-Broach block and (V) Narmada-Tapti Block.

Varying tectonic mobility preferred Dharwarian-Satpura-Aravalli gains have influenced the depositional history and structural styles of the individual tectonic blocks.

LITHO-STRATIGRAPHIC SEQUENCE

Geologically the State of Gujarat demonstrates numerous peculiarities in terms of diverse nature of rock types belonging to various age groups. Baring Paleozoic sequence perhaps this is the only state, which represents a well-developed and ideally exposed litho-stratigraphy bounded within distinct tectonic domains.

The study area also forms a part of one such tectonic domain- the Cambay Graben, an important depositional basin representing vast accumulation of Tertiary and Quaternary Holocene sediments of fluviatile and marine nature on Mainland Gujarat. The entire basin is largely concealed under the Sub-Recent to Recent alluvial cover. The basin in its west and east margin is fringed by the Cretaceous and Tertiary sediments and volcanic effusive of the Deccan trap. These sediments are exposed as isolated outcrops. The basinal sediments of fluvatile and marine origin rest on the Pre-Cambrian basement. The Cambay basin, being an important oil and natural gas bearing domain; the data available on lithostratigraphic aspects of this basin are in great details. The valuable contribution has been made by the workers of ONGC viz. Zubov, et. al., 1966; Mathur et. al. 1968; Raju, 1968; Rao 1969, Sudhakar and Basu 1971, and Mehrotra and Ramakrishna, 1980.

Table 2.1 Litho-stratigraphic Sequences in Cambay-Tarapur Block.
(After Pandey et. al., 1993)

Period	Formation	Thickness 'm'	Lithology	Depositional Environment
Recent to Pleistocene	Gujarat Alluvium	50-100	Yellow Grey Sandy Clay	
	Jambusar	300	Yellow Grey Clays, Coarse Sand, Gravel and Kanker	Regressive shallow marine
Pliocene	Broach	300	Chocolate Brown and Red Brown Claystone, Sandy Claystone and Sandstone	Shallow marine
Up. Miocene to M. Miocene	Jhagadia	200	White and Gray Calcretes and Micaceous Sandstone, Gray Shaly Sandstone and Sand	Continental and marginal marine
Mid. Miocene to L. Miocene	Kand	200	Grey Clay and claystone with Micaceous Sandstone, Grey Shaly Sandstone and Sands.	Shallow marine
Mid. Miocene to L. Miocene	Babaguru	300	Ferruginous Sandstone, Conglomerate and Gray Clays and Claystone	Fluvatile to shallow water
			Unconfirmity	
Oligocene to Up. Eocene	Tarapur Shale	200-300	Greenish grey to dark grey Shale, Silty and sandy shale and Argillaceous sandstone,	Regressive marine
Up. Eocene to Mid. Eocene	Kalol	200-300	Calcareous Sandstone, Silty shale and Siltstone, Sideritic claystone, Dark grey shale and Coal	Regressive and transgressive marine
			Unconfirmity	
Lower Eocene	Younger Cambay Shale	500-750	Dark grey to grey Shale moderately hard, massive sand, Sandstone, Carbonaceous, dark grey Shale and Coal	Lagoonal and paludal
Paleocene to L Eocene	Older Cambay Shale	500-750	Dark Grey to Black fissile shales, hard and rich in organic matter	
Paleocene	Olpad	300	Volcanic Conglomerate, Sandstone, Silt, Claystone, and clay light grey to reddish brown	Fresh to Brackish water Coastal
			Unconfirmity	
Upper Cretaceous	Deccan Trap	300-3000	Basalt, Andesite, Trachyte, Picrite and Syenite etc.	Igneous
			Unconfirmity	
Mesozoic	Dhandhuka	350	Felspathic argillaceous Sandstone, sandy shale, impure limestone	
			Unconfirmity	
Pre-Cambrian	Basement Complex		Granite, Olivine Gabbro, Syenite	

However, the most comprehensive account has been documented by Chandra and Chowdhary (1960) which has been recently modified by Pandey et. al. (1993), considering the difference in the depositional history of an individual tectonic blocks. Present study area falls under one such block of the Cambay basin i.e. the Tarapur-Cambay block. The detailed stratigraphy of this block is given in Table 2.1.

Sedimentation history of the Cambay basin has evolved through four tectonic cycles. First cycle initiated during the Paleocene- early Eocene and last cycle culminating during the post-Miocene/Pliocene period (Raju, 1968; Raju and Srinivasan, 1983). During the first stage, the sediments indicate their deposition close to the site of weathering across the fault scarp (Olpad formation and lower Cambay shale). The period of marine transgression is indicated by the presence of dark grey to black shales, pyritic and rich in organic matter in the form of upper Cambay shale. The tectonic movement of the Indian plate resulted in the development of basin during the middle Eocene times and the river system were activated to the development of deltaic environment and reflected by arenaceous deposits in the form of Kalol formation. During late Oligocene Miocene period tectonic movement resulted in landward tilt of outer continental margin, which marked the regressive phase. Continental fluvial deposits resulted in the Neogene-Quarternary fill of basin.

QUATERNARY - HOLOCENE SEDIMENTS

Cambay basin comprises interesting and well-developed Quaternary-Holocene sedimentation records. However, information on Quaternary stratigraphy is highly fragmentary. Major work, which has come from the Department of Geology, M. S. University of Baroda is restricted to the river cliff sections and represents an independent river wise stratigraphic system. No comprehensive and complete information, encompassing total Quaternary stratigraphy is available. Therefore, the author has simply taken the basis of bore-hole litho-logs for working out the stratigraphic column, without assigning any stratigraphic nomenclature. The overall Quaternary-Holocene stratigraphic column of the study area has been prepared through the bore-hole litho-logs. The sediment represents an intercalated sequence of clayey and sandy material. However,

the entire sequence with an overall thickness of more than 350 m. is predominated by the clayey sediments.

A subsurface geological cross-section giving an idea about lateral and vertical variation is shown in Fig. 2.3. It gives general idea that how these non-inundated sediments which represent lower Jambusar formation and upper Gujarat Alluvium (Pandey et al., 1993) have been deposited under tectonically accentuated depositional surface.

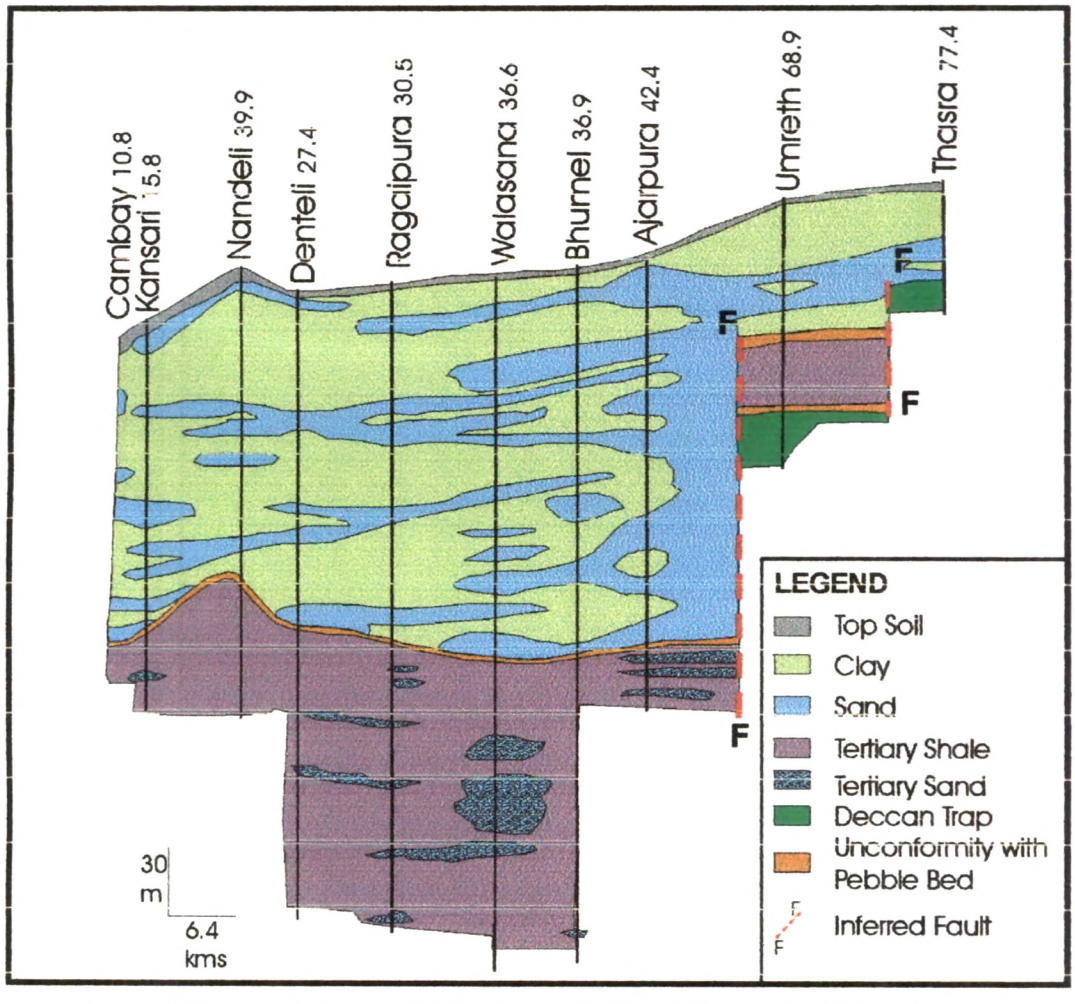


Fig. 2.3 Sub-surface Geologic Profile in MRBC Command Area

The fault controlled basement with westward down throw as well as the increase in sediments thickness from a few tens of meter to few hundred of meters are bare

testimony of this fact. Through the borehole litho-logs it is not possible to establish and demarcate the boundaries between Jambusar Formation and Gujarat Alluvium. However, the displayed disposition pattern of the sediments clearly indicates the occurrence of three major sandy layers separated by clayey sediments, which is significant for the development of confined - semi confined aquifer system. The details for which have been dealt separately in the chapter on Hydrogeology.