CHAPTER - II

B A C K G R O U N D I N F O R M A T I O N

GENERAL ASPECTS

The exposed Tertiary rocks, between the Narmada and the Tapti rivers, in the state of Gujarat, have attracted attention of many geologists in the past. The earliest reference to these rocks are found in the work of Medlicott (1860) who investigated this part of western India almost 130 years back. Blandford (1869) was the next geologist of the Geological Survey of India to write about these Tertiary exposures. Bose (1908) also of G.S.I. was the first worker to describe these rocks in somewhat greater detail. Subsequently, Narayan Rao (1939a : 1939b) worked out the Tertiary stratigraphy in somewhat detail. The following officers of the Oil & Natural Gas Commission (ONGC) viz, Agarwal (1983a, 1983b),

Chandra & Chowdhary (1969), Mathur, Rao & Chaube (1968), Raju (1966), Rao (1969), Sengupta (1967), Sudhakar (1973) and Sudhakar, Khan & Ahmad (1970) however, have investigated in great detail the various aspects of these Tertiary rocks, and their work has been found to be fairly precise as it was based mainly on subsurface data. The subsurface geological and geophysical data obtained by the ONGC, in the exposed as well as the adjoining area covered by alluvium, have provided a three dimentional view of the geology of the area. Some aspects of the stratigraphy and sedimentation of the exposed Tertiaries around Jhagadia were worked out by Gadekar (1975) in his unpublished Ph.D. thesis and subsequent publications (Gadekar, 1976, 1978, 1980a, 1980b).

Though in recent years, a lot of data have been generated on the rocks of Cambay basin, and the published work on the Tertiary rocks provides a good insight into the post-Mesozoic geological history of Gujarat, one is unable to obtain an integrated picture of the geological evolution of the area in terms of precise structure, tectonic history, geomorphological features and neotectonic activity. With the purpose of providing appropriate background to the present study a brief account of the geological investigations carried out by different authors in the past has been given in the following pages of this Chapter.

The scope of previous investigations could be grouped

under (1) Stratigraphy, (2) Bio-stratigraphy, (3) Geomorphology and (4) Structure and Tectonics.

STRATIGRAPHY

Medlicott (1860) had for the first time studied and reported the occurrence of Tertiary rocks, south of Narmada river, in Gujarat. Blandford (1869) studied the area between Narmada and Tapti rivers in detail, and gave a general geological account. He recorded two areas of Tertiary outcrops near Jhagadia and Tarkeshwar towns separated by an alluvial patch of the Kim river.

Mathur & Evans (1964) gave a general account of the subsurface geology of the Cambay basin as a whole from the data of deep wells drilled in Gujarat for the exploration and production of oil and gas. Mathur et.al (1968) and Raju(1966) studied the tectonic framework and geological evolution of the Cambay basin evaluating the subsurface geological data.

Rao (1969) correlated the subsurface lithounits from the electrolog characters observed in deep wells with the exposed Tertiaries and prepared sand isolith, isopach and sand-shale ratio maps.

Chandra & Chowdhary (1969) worked out the subsurface stratigraphy of Tertiary sequence of Cambay basin from the data

of deep wells. Sudhakar & Basu (1973) studied the Paleogene stratigraphy of the southern Cambay basin and evaluated both outcropping and sub-cropping formations, indicating the environments of deposition of different sedimentary sections. Raju & Rao (1975) studied the depositional environments of Eocene sands of Anklesvar oil field from the petrography of cores cut in deep wells, and according to these authors the lower sands were deposited along distributory channels, over interchannel tidal-flats, and along tidal-inlets in a tidal-estuary, while the upper sands comprised material of a barrier beach in a transgressive open marine environment.

Gadekar (1975, 1976, 1978, 1980a and 1980b) studied the exposed Tertiary rocks around Jhagadia town with special reference to sedimentary structures, particle size determinations for reconstruction of depositional environment, heavy mineral and petrographic analysis for the inference of provenance and depositional environment, and some aspects of diagenesis of the Tertiary sediments.

As compared to Tertiary much less data on Quaternary is available in previous studies. Recently, Mukherjee (1980) has described the Quaternary sediments of the area of Cambay basin south of Narmada river in Gujarat from the electrical logs of wells drilled. He has divided the 150 m thick succession into 5 litho-units. The units in ascending order are sandstone-conglomerate unit, dominantly shale unit,

siltstone-clay unit and clay unit. The sediment character, faunal and floral assemblages of Quaternary sediments were indicated to represent a shallow marine environment of deposition during the two lower units, and fresh water deposition during the upper three units.

BIO-STRATIGRAPHY

Carter (1854) was the first worker, to have carried out the faunal study of the marine Tertiary rocks of Surat and Broach area. Wynne (1862-63) published its stratigraphic successions.

Bose (1908) investigated the Tertiary outcrops, and indicated the presence of an anticlinal structure along the Ratnapurni river between Damlai and Ratanpur villages. Fossils found in the limestones, conglomerates and grits in Amravati river section near Vagalkhod village were studied and the species identified by him were as follows:-

a) Foraminifera-Nummulites ramohdi Defr., Assilina exponens, Discocyclina dispensa, Nummulites obtusus.
b) Lamellibranchiata - Liostrea flemingi.
c) Gastropoda-Rimella prestwinchi, Vulsella legumen, Ampulina flemingi, Ampulospira owenie.

He assigned a Paleoeene to Lower Eocene age to the lower part of the sequence which had the above fossil assemblage; he found

the upper section to be poorly fossiliferous.

Narayan Rao (1939a, 1939b and 1941) studied the fossil remains of the southern patch of the Tertiary outcrops near Tarkeshwar close to Tapti river. He identified the following species of foraminifera : Nummulites thalicus, Nummulites Discocyclina ranikotensis, and Siderolites, and assigned a Lower Eocene age to the limestone rocks and correlated them to the Ranikot sequence of Sind. The fossils in agate conglomerate and ferruginous sandstone were found to represent the following species of foraminifera : Lepidocyclina canelli, and Lepidocyclina sumatrensis, suggesting a Middle to Lower Miocene age, correlatable them with the Gaj sequence of Sind.

Datta (1964) carried out micropaleontological investigations of some surface samples from Baroda and Surat-Broach area. In a personal communication, he had mentioned the occurrence of the following foraminiferal species:

Virgulina schreibersiana Czjzek ,
Cibicides lobatulus ,
Cibicides exgr.minusculus Bermudes;
Streblus gaimardu (d'Orbigny);
Elphidium subnosodum (Munster)

No specific age was assigned to the outcrops by him.

A new species of Anomalinella has been described by Singh (1972) from the upper Eocene of Surat. The author has, however, not mentioned the exact location of the sample and the name of the formation. Most probably he collected the sample from a spot that is south-east of the area of the present study.

Guha & Pandey (1980), with the help of well electrical logs, made a correlation of the subsurface sequence of Oligocene-Miocene age of south Gujarat with Tarapur offshore well. The electric logs of wells of Aliabet Offshore, Dumas, Bhandut, Olpad, Hazira, Surat, Puna and Tarapur Offshore areas were used for the detailed correlation of sand beds. Sands were indicated to have been deposited between the limits of the inter-tidal zone.

GEOMORPHOLOGY

A very general geomorphological analysis was made by Babu (1977) of the Cambay basin. The morphostructural distribution was studied on the basis of tonal contrast and drainage pattern. He had indicated a general NE-SW pattern of structural trends in the Cambay basin in conformity with the Aravalli and the Kutch structural trends. He had contended that in between Surat and Cambay the Aravalli trend is reflected.

A number of Quaternary landforms and lineaments had been identified by Mukherjee (1980) in the southern part of the Cambay basin. He had observed that the east-west alignment is younger than the north-south one.

STRUCTURE AND TECTONICS

The Cambay basin, was considered by Mathur et.al (1968) as an intracratonic basin, and divided them into four tectonic blocks (1) Narmada, (2) Jambusar-Broach, (3) Cambay-Tarapur, and (4) Ahmedabad-Mehsana. They further observed that the Narmada block has structural features parallel to the Narmada fault.

The deformation of the Tertiary and Quaternary sediments, exhibiting a prominent ENE-WSW trend between the Mahi and the Tapti rivers might have been originated due to compressional forces, was considered by Sudhakar et.al (1970). It was also opined by them, that the shear zone or fault of assymetric fold continues into the basement and is of a reverse type, and that there are minor evidences of repetition of strata in the steeper limb.

Raju et.al (1971), however, studied the geological framework of the Cambay basin in greater detail and indicated that three main tectonic trends, essentially parallel to the Dharwar, Satpura and Aravalli Lineaments, determined the

structural setting of the basin; they had also suggested that synsedimentary Trap tectonics controlled the genesis of distinct lithologic suites.

Das & Ray (1977) studied the fracture pattern and the orientation of dykes in the western part of the Narmada and Tapti valleys. They considered that the east-west set of fractures are older than the north-south fractures. The east-west fracture trends in Traps cross over to Tertiaries in the west. The Narmada fracture and dyke trend continues right across the Cambay through into the southern margin of Saurashtra Peninsula.

According to Mukherjee (1981), the Anklesvar anticline was initiated in Late Cretaceous time, and the structure continued to grow but became prominent during middle Eocene time with major development at the end of Oligocene. It continued to grow during the post Oligocene to its present form. Differential fault-block movement occured during Paleocene. The south Anklesvar system of reverse faults started growing at the end of the Oligocene.

Kaila (1982), on the basis of Deep Seimic Sounding (DSS) studies, along a N-S profile in Cambay basin, had demarcated the configuration of the top of Deccan Traps and the granitic basement under the Tertiary sediments. The thickness of

Deccan traps near Tapti river is 1.8 km. In the Anklesvar-Kosamba area about 1.2 km thick Mesozoic sediments were inferred under 1.1 km thick Deccan Trap cover. The DSS data had yielded information on the deeper basement tectonic features, and the presence of Mesozoic sediments between the granitic basement and the Deccan basalts.

Biswas (1982) had postulated that the three craton-margin embayed basins - Kutch, Cambay and Narmada-predominantly filled with clastic sediments occupied grabens bounded by faults. The grabens were formed by three rift systems along major Pre-Cambrian tectonic trends. The Cambay basin was stated to have been formed in the Early Cretaceous and the Narmada basin in Late Cretaceous. It had been inferred by him that these rift basins opened up successively as a result of the counter-clockwise drift of the Indian craton during the northward migration of the Indian Plate after its break from the Gondwanaland.

Rao & Talukdar (1982) while describing the Petroleum Geology of Bombay High Field, discussed the structural aspects of the Cambay basin also. They had significantly observed that the Cambay basin appears to terminate abruptly south of Narmada River, and that all the structural elements, north of the river, have a NNW to SSE (Dharwarian grain?) trend. The western marginal fault of the Cambay basin is down-thrown towards the east and apparently continues into the eastern

margin of the Bombay Offshore basin.

Agarwal (1983a) studied the Tertiary outcrops and adjoining Deccan Traps in the area between Rajpardi and Anklesvar towns. From the study of the air photos, Landsat Imagery and ground surveys, he could observe tectonic activities in Late Tertiary and Quaternary times. He had delineated the Narmada river paleo-bank 6 km south of the present course of the river and recorded a gradual migration of the river northward. He was the first to postulate the Narmada fault as a reverse fault dislocation on the basis of a N-S seismic section. He had mapped a number of SW and NW trending lineaments from Landsat Imagery in the adjoining Deccan Trap country to the east.

The structure and tectonic history of the south Cambay basin studied by Agarwal (1983b), had revealed the presence of four phases of tectonic activity in Paleocene, Lower Eocene, Mio-Pliocene and Quaternary periods. He had concluded that the first two tectonic phases had controlled the faulting of Deccan Traps forming horsts and grabens, and the deposition of sediments in the structural lows. South of the Narmada river in the Anklesvar block, the lower Tertiary sequence was folded and partially eroded during a sedimentary hiatus. With the Middle Eocene marine transgression in the area, sedimentation commenced with an angular unconformity. After the uniform sedimentation upto Mio-Pliocene times another tectonic activity

caused the differential vertical basement fault-block movement resulting in the formation of the SW trending anticlinal and synclinal structures accompanied with reverse faulting along the SE limbs of Anklesvar, Kosamba and other anticlines in the Anklesvar block. Partial erosion of the topographic high parts of the uplifted structures took place during Late Pliocene and Quaternary times. The reactivation of mild tectonic activity in Quaternary is manifest in the form of neo-tectonic and geomorphic features.

Significant observation have been made by Ganapathi, Desai & Merh (1983) on the periodic movements along the Narmada geofracture system during the Quaternary period indicating that these movements had controlled the Quaternary sedimentation and the morphology of the Gujarat coast. They had opined that the two major upheavals - one at the close of Middle Miocene (Post Gaj) and the other in the Upper Pleistocene, had taken place in the coastal areas of Gujarat.

A review of the work carried out so far on the Tertiary stratigraphy of the exposed sequence between the Kim and Narmada rivers in Gujarat would bring out the lack of unanimity regarding nomenclature and stratigraphic positions of the formations and their sub-divisions. Attempts have been made earlier to correlate the outcropping Tertiary rocks with the subsurface litho-units observed in deep wells drilled in the

Anklesvar and Kosamba areas to the north-west and west, but no precise correlation with the help of detailed lithology and micro-faunal evidences has been brought out so far. The boundary between the fossiliferous limestone of Dinod formation and the overlying ferruginous sandstones of Babaguru formation had not been properly mapped. The limestones of Dinod formation exposed in the Dinod and Dungri areas have been correlated with the subcrop limestone of Anklesvar area, and had failed to find that the former is of Late Eocene age. The variegated lutites, lignites and laterites mapped by Gadekar (1975) under Tarkeshwar formation and as of Oligocene age have been found on mapping as part of Babaguru formation. The Oligocene sea in fact did not extend towards the area of study. The north-south trending beds, south of the Jhagadia anticline, mapped by Gadekar (1975) have been found to be incorrect.