CHAPTER - VII

CENOZOIC SEDIMENTATION AND ENVIRONMENT OF DEPOSITION

GENERAL

The sedimentation processes and the environments under which lithological suites have been deposited are reflected in their lithology, facies variations, mineralogical compositions, textural changes, and faunal and floral contents. The variations in these characteristics are observed to have taken place laterally as well as vertically depending upon the basin configuration and transgressions and regressions that had taken place. The in-put of detritus in a basin would be dependent upon theuplifts in the provenance areas, and also on the fact

whether the distance of transportation of material was long or short. A lithologic suite is a sequence of beds consisting of paragenetically inter-related litho-facies derived, deposited and buried to form rock units in a particular geographic, geochemical and geotectonic environment.

As already stated, the exposed Tertiaries, on which this study dwells upon is located in the marginal part of the Cambay basin, and the detailed investigations by the present author have brought out valuable information. The sedimentation processes and environments of deposition of the Tertiaries of the Cambay basin can be very well understood to a considerable extent, from the study of the exposed Tertiaries. The geological data obtained, from the deep wells drilled by the Oil & Natural Gas Commission in the deeper parts of the Cambay basin, have also provided information on these processes, and by combining the two, the present author has been able to obtain a more clearer picture of the depositional history.

CAMBAY BASIN TERTIARY SEDIMENTATION

On the basis of gross lithology, the Tertiary sequence of the Cambay basin was considered to have been deposited in four stages (or cycles) giving rise to distinct litho-suites and the different suites were related to the tectonic evolution of the Cambay basin (Raju 1968). During the formative or wa[illegible]ke stage of development of the basin, a thick sedimentary section

consisting of trap/basalt conglomerates, sandstones, siltstones and claystones were deposited over the basaltic floor. This was followed by the deposition of uniform dark-gray to black fissile shale, commonly pyritic and rich in organic matter. This litho-unit is rich inmicrofauna, and has been found to be of Early to Middle Eocene age, and is developed throughout the basin except along the margins of the basin where the Miocene sediments are seen to directly overlie the Trap. The source of these sediments was weathered basalt which had supplied fine detritus to the depositional sites. The sequence had attained maximum thickness in the central part of the depression which was obviously subsiding at a greater rate than the basin marginal areas. That the environment of deposition in deep marine waters was marked by highly reducing condition, is indicated by the predominance of euxinic shales in the section, and the presence of glauconite in the upper part of the sedimentary sequence suggests shallowing of the basin.

This was followed by an oscillatory stage or a stage of inversion in which a suite of alternating light to dark-grey fissile shale, greenish-grey chloritic shale, carbonaceous shale, coal beds, sideritic mudstones, siltstones and sandstone beds were deposited. In some parts of the basin, cyclic deposition is indicated by gradation from pyritic dark-grey shale to sandstone or siltstone, through carbonaceous shale to coal beds. This formation is characterised by rapid

thickness variations and facies changes implying that the deposition had taken place in an unstable basin conditions. These sediments, deposited under such environment which had changed in time and space from shallow marine to littoral and lagoonal conditions, point to rapid facies changes. At times, the marine reducing conditions alternated with brackish and even mild oxidising conditions.

During the last stage, the basin was characterised by an unstable platform type environment. The resulting sediments are essentially arenaceous, their lower parts consisting of olive-green, grayish-green, brownish-gray and variegated claystone which are locally pyritic. The upper part contains frequent pebbly sandstones and brownish claystones, Jasper, flint and agate pebbles are the main constituent. The sandstones are chloritic, and some beds contain kaolinitic matrix. The mineralogical composition indicates an admixture of metamorphic and basaltic material. The basin was shallow and the environment was continental to shallow marine. This lithologic suite indicates a change in the drainage pattern as the metamorphics became the main source of the material. Frequent epeirogenic movement caused temporary marine transgressions. The uplift, in the source area, is reflected in poorly sorted sand, gravel, and conglomerates of continental type that accumulated along the basin margins and overlapped the basaltic floor and the basement in some areas.

The epeirogenic movements of the platform caused the gradual emergence of the Cambay area and the withdrawal of the coastline to the south.

CAMBAY BASIN QUATERNARY SEDIMENTATION

The Quaternary sediments have a very extensive distribution, and completely cover up the limits of the area of Cambay Tertiary basin. The sediments extend far beyond the marginal areas of the Pliocene deposits of the basin. They are thickest in the central axial part of the Cambay basin. The sediment transport had been through the basin margin drainage system. A critical scrutiny of all available data, very clearly reveals evidences to suggest that during the Quaternary times, the axis of the Cambay basin had shifted westward. The remnants of the withdrawn sea are marked by the Nal lake, and hundreds of other lakes and ponds along the NNW-SSE alignment passing through the Nal lake, and west of Cambay town far to the north of the study area.

The Quaternary sediments essentially consist of unconsolidated sands, gravels and silty clays which are brown and earthy. Their mineralogical composition suggests a wide variety of provenances. The boundary between the Pliocene and the Pleistocene is difficult to define due to a gradual vertical gradation and absence of diagnostic floral or

faunal remains in the sediments. It is however, obvious that the major rivers of the area viz. Narmada, Dadhar, Sabarmati and their tributaries, draining a vast area had played an important role in the transportation and deposition of Quaternary sediments. The Quaternary sedimentation was controlled by the last phases of the Cenozoic tectonic activity, and the present day morphology of the coastal areas around the Gulf of Cambay also point to a significant neotectonic control. In a way, the processes of fluvial sedimentation initiated during the advent of Pleistocene, are continuing to the present-day.

SEDIMENTATION AND ENVIRONMENT OF DEPOSITION IN STUDY AREA

The study area is located within the zone of intersection of the Narmada and Cambay basins. The Narmada basin began with Cretaceous sedimentation, following the formation of the Narmada rift basin, and in all probability the Cretaceous sequence lies underneath the Tertiaries of the study area. At the close of the Cretaceous, lava flows, along the tensional fissures associated with the deep seated faults of the Narmada rift basin, gave rise to basalts. In the western part of the Narmada rift basin, which was part of the N-S trending Cambay rift basin during early Paleocene, became a negative area. The study area falling in this part comprised of SW-NE trending horsts and grabens bounded by tensional faults. The grabens were filled up with the trap-wash

material consisting of trap conglomerates, sandstones, grits, variegated clays of red, pink, yellow and brown colours with agate and trap pebbles in the rudaceous sequences. During this time the trap rock of the adjoining horst blocks were also being eroded and deposited within the basin. The environment of deposition was essentially continental as evidenced from the lithological composition and lack of fossiliferous sequences. The Vagadkhoi formation overlies the Deccan Trap with a pronounced unconformity. In the study area this sequence is present in the eastern part and is exposed along the SW margin of the Deccan Trap outcrops. From the outcrop pattern, it is observed that these sediments were deposited some distance away to the NE of the present outcrop limit, and the present NE limit of the outcrops, comprises an erosional limit/boundary. In the deeper parts of the basin the facies change to finer clastics had taken place as evidenced from the subsurface geological data.

At the close of the deposition of the Vagadkhol sequence differential vertical fault-block movement affected the study area, thereby folding, faulting and uplifting the entire sequence along the pre-existing faults. It may be emphasized that originally these faults had normal movement but during their renewed uplift, the sense of movement was of reverse type. The uplifted Vagadkhol sequence was subjected to partial erosion followed by a widespread marine transgression in the Cambay basin. The Early to Middle Eocene marine transgression

gradually extended toward the margins of the basin and by Late Eocene, the study area came under marine sedimentation depositing foraminiferal limestone and marly clays. An angular unconformity marks this. A shallow marine shelf edge environment which was prevailing in the study area is indicated from the large size of the foraminifers and coquina beds. Further evidences of near shore environment are found from the presence of yellowish brown marls.

The regression of the sea during the Oligocene was an important event in the Cambay basin. Only in the deeper parts of the basin, sedimentation in Oligocene had taken place (Fig.V.1). The study area, on account of being located at the eastern margin of the basin, had a thin deposition of Babaguru formation represented by highly ferruginous agate conglomerates and ferruginous sandstones derived from the weathered trap that was exposed in the vicinity. These sediments occur with a pronounced unconformity over the fossiliferous limestones of the Dinod formation of Late Eocene age. The mineralogical composition of the Babaguru formation point to an environment of deposition that was continental, the uplift in the provenance area to the NE of Deccan Trap had provided the detritus to the depositional site as flood plain deposits through a reactivated drainage. The pebbles and cobbles of agate present in the conglomerates clearly indicate the transportation and the deposition near the provenance of Deccan Traps, and the climatic conditions were

hot and dry.

During Miocene, once again the area witnessed a marine transgression and in the study area the Kand fossiliferous limestones, calcareous sandstones and calcareous clays and marls were deposited. A change in the provenance is revealed in the mineralogical composition of the sediments. The presence of quartz and heavy minerals in sands and siltstones indicate a metamorphic (Aravalli) provenance.

The basin, thereafter, had become shallow and the environment comprised shallow marine to continental with the gradual regression of the sea. The sediments deposited were sandstones, conglomerates and clays under shallow, less saline waters with increasingly deltaic environment toward the upper part. The Jhagadia formation of Miocene age is marked by current bedded sandstones and conglomerates with pebbles of quartzite, sandstones, agate and occasionally of basalt. This suggests a close provenance of metamorphic terrain with an admixture of Deccan Trap. The presence of graded bedding, cross bedding, and rapid alternations of sandstones and conglomerates suggest fluviatile conditions of deposition.

Sedimentation in the study area appears to have ceased due to the Mio-Pliocene uplift, but sedimentation continued in the adjacent area to the north of the Narmada river due to down faulting. However, Quaternary sedimentation took place

in the low lying synclinal areas and along the valleys of the Narmada and Kim rivers consisting of residual soil derived from the exposed Deccan Trap and the older Tertiaries, the black cotton soil and flood plain deposits.