CHAPTER - VII

CHAPTER 7

CONCLUSION

Bhavnagar district forms the south-eastern corner of the Saurashtra peninsula of Gujarat state. The coastal segment of Saurashtra is well known for its huge mineral deposits formed due to the weathering/lateritisation processes. In the present study area laterites have developed over the Cretaceo-Eocene Deccan trap flows. The common occurrence is in the form of a narrow, elongate, N-S band, 2 km in width, extending to a length of about 30 km, commencing from east of Adhevada to Mithivardi passing through Budhel, Tagadi, Thoradi and Alang. The unique feature here is the occurrence of large economic deposits of bentonite associated with the lower parts of the lateritic weathering profile. The Bentonites occur as pockets and tabular bodies

scattered along the contact of Deccan basalts and laterites and also appear to fill small basins in the Trap country.

The study area in Bhavnagar district has been restricted to the occurrence of bentonites and lies between 21° 15′ and 21° 45′ north latitudes and 72° 0′ and 72° 15′ east longitudes and forms a part of the Survey of India Toposheet numbers 46 C/2, 46 C/3 and 46 C/7, (1:50,000) covering an area of 60 sq km.

The most important bentonite pockets in the study area are located in and around Budhel, Adhevada, Tagadi, Thoradi, Rajpara, Morchand, Padwa, Thalsar, Tansa, Alang, Mathwada, Devaliya and Sakhavadar villages.

The present study has been undertaken with an aim to establish the geology, mode of occurrence, genesis and industrial utility of the bentonite deposits.

Field work in the bentonite bearing area includes critical examination of all available mines, pits, rivers, and hill sections, which has been followed by systematic sampling. The field characters and the nature of occurrence of bentonite points to the insitu nature of these deposits. This in turn is supported by the presence of major and minor elements, trace elements and XRD studies. The field characters and laboratoty studies indicate that there had been both vertical as well as lateral differentiation of major elements within the insitu weathering profiles developed over the Deccan basalts leading to the formation of bentonites and laterites.

The generalised stratigraphy of the Bhavnagar district of Saurashtra peninsula is as follows.

FORMATION	LITHOLOGY	AGE
Gaj	conglomerate, sandstone, shale	Miocene-Pliocene
---	laterite, lithomarge bentonite	Eocene ?
Deccan Trap	basalt and its varities	Upp. Cretaceous to lower Eocene

Study of the different mines and quarry sections, and field exposures show that there are two distinct modes of occurrence of bentonites in the area viz., the insitu type and secondary type. Although majority of the deposits in the area are of insitu type, however, there are examples of bentonite deposits formed on account of reworking also.

The generalised weathering profile as observed in the study area is as follows.

Weathering Profile

- Soil
- Laterite
- Lithomarge
- Bentonite
- Weathered basalt

Basalt is overlain by bentonite, lithomarge and laterite in succession with gradational contacts. The field characters such

as, the presence of relict amygdaloidal structures within the bentonites indicate an insitu alteration of the basalts leading to the formation of bentonite. This is further supported by the presense of corestones of basalt and relict rims of spheroidal weathering within the benonites. Thin calcite and gypsum veins often traverse the bentonite belt.

Outcrops of transported of bentonite occur near to the insitu deposits. The transported bentonites overlie the eroded surfaces of the basalts, with or without intermediate sedimentary layers. The chief intercalating layer is a hard conglomerate with pebbles cemented in a siliceous clayey matrix. Secondary bentonites that shows slaty cleavage, are gypsiferous, less sticky and show feeble swelling.

Origin

An attempt has been made to bring out the origin of the bentonites and its genetic relations with the laterites. The primary bentonite is thought have been formed by the insitu alteration of the Deccan basalts and has been recognised as the beginning phase of the major process of lateritisation. This is a residual process which involves the physico-chemical changes in Deccan basalts depending on the climate, topography and the character of the bedrock.

According to models of palaeo-geography for Eocene (Frakes & Kemps, 1973), India must have been lying a few degrees to the south of the equator, while in Oligocene it has drifted a few degrees to the north of the equator. In both cases it experienced

high temperature and high precipitation which is essential for laterite formation. The flat topography of the Deccan basalts must have played a major role for the lateritisation process to commence. The present day laterite ridges are the erosional remnants of the blankets of laterite formed in the past (Patel, 1987).

Under favourable climatic and topographic conditions the Deccan basalts are thought to have been subjected to weathering according to the model suggested by Trendall (1962). The occurrence of moist bentonite in Bhavnagar indicates a large range of water table fluctuation. Ollier (1972) has stated that the spheroidal weathering is also due to constant volume alteration where the, layers in a spheroidally weathered are caused by chemical migration of elements within a rock as a result of hydrolysis.

The main minerals present in the Deccan basalts are labradorite, augite and olivine. All along the coast, the basalts have been considered to be attacked along the joint planes giving way for the process of lateritisation to commence. This may be due to the profusions of cooling structures and joints which might have been produced on the leading edge of the Deccan basalts when it must have come in contact with the early Tertiary sea, affording a high degree of free drainage.

The weathering is thought to have occurred in three stages

a) The break down of parent material structures with the concomitant release of the cations and silica.

b) The removal in solution of some of the released constituents.
c) The constitution of the residue with components from the atmosphere such as water, oxygen and carbon dioxide to form new minerals.

At this stage the pore solutions are high in alkalies and alkaline earths due to which calcite and gypsum is deposited. The immobile ferric iron is converted to the mobile ferrous form under waterlogged conditions. Alumina is not mobile in alkaline medium while silica goes into soluition. At this stage the presence of bases enhanced the formation of montmorillonite and kaolinite. In the lithomarge band the initial pore solutions high in alkalies is thought to be gradually removed. At the same time the downward percolating waters containing dissolved carbon dioxide must have increased the acidity of the medium. The removal of silica increased the porosity and permeability of the lithomarge. The transformation of montmorillonite into kaolinite must have been on account of crystalline leaching of inter layer cations and tetrahedral silica layers. The X-ray diffraction studies verify the above changes.

The laterites overlying the lithomarge is considered to be the zone of enrichment. The oxidising conditions and the rain water containing dissoved carbon dioxide that prevailed at the surface regions must have affected the chemical balance of the alkaline pore solutions. The increase in the acidity and the subsequent oxidising conditions must have changed the mobile ferrous iron into the immobile ferric form which has deposited as laterite.

As alumina is mobile in this medium it must have been washed away. The absolute enrichment resulted in the separation of the ferralite and siallite components to form hematite and goethite at one end (represented by laterite) and koilinite at the other (represented by lithomarge).

The major elements (Fe, Al, Si, etc.) and the trace element Zr, Cr etc.)studies prove the insitu nature of the bentonites which on reworking have been deposited as secondary bentonites in the nearby areas.