

CHAPTER - III  
PREVIOUS STUDIES ON LATERITES OF GUJARAT

HISTORICAL PERSPECTIVE

GENETIC ASPECTS

## PREVIOUS STUDIES ON LATERITES OF GUJARAT

### HISTORICAL PERSPECTIVE

Laterite and bauxite deposits of Gujarat, occurring in Kutch, Saurashtra and Mainland Gujarat, have by and large received little attention in the past. Most of the previous studies pertain to the economic aspects, although some studies in more recent years have aimed at discussing the genetic aspects as well. Laterites of Kutch have been better investigated, whereas those of Saurashtra and Mainland are yet to receive adequate attention.

Earliest reference to these rocks in the region between Narmada and Tapi rivers was made by Blanford (1869). He mentioned interstratification of beds of laterite with Nummulitic limestones and gravels. Wynne (1872) while describing the geology of Kutch, referred to these rocks as "Volcanic Tertiaries", occurring "along with sub-nummulitic stratified traps". He has stated that the bentonite and associated rocks of Kutch formed during Eocene times. He also made a reference to laterite and related aluminous rocks. According to him, these

rocks were composed of pyroclastics which might have formed under sub-aqueous conditions.

Earliest reference to Saurashtra laterites was made by Fox (1923). Later on, private prospectors investigated these rocks for bauxite from various areas in early fifty's, of which no published account is available. First ever mention of North Gujarat laterites is found in the work of Gupta and Mukherjee (1938). These workers erroneously correlated these laterite-bauxite rocks with Ahmednagar Sandstone, viz. Infra-trappean.

Bauxite and laterite occurrences of Kutch were also reported by Poddar (1955) and according to him the laterites were of Lower Eocene age resting unconformably over the Deccan Trap. While describing the stratigraphic set up of North Gujarat laterite occurrences, Mohinuddin (1960) gave the following sequence :

<u>Formation</u>	<u>Thickness</u>	<u>Age</u>
Alluvium, Conglomerate pebbles, alluvial clays and sands	10' to 60'	Sub Recent to
Jorapur Sandstone	10' to 50'	Recent
----- Erosional Unconformity -----		
Laterite & Lateritic clays	10' to 70'	Lower Eocene to Sub-Recent
Deccan Trap	65' to 70'	Upper Cretaceous to Upper Paleocene
----- Unconformity -----		

Balasinor Formation	10' to 25'	Cretaceous
Himatnagar Formation	50' to 170'	(Turonium)
----- Unconformity -----		
Alwar quartzite     Delhi	}	Idar granite
		intrusive
----- Unconformity -----		
Gneisses, phyllites, schists quartzites		Aravalli

While describing the geology of the Cambay basin, Chandra and Chowdhary (1969) have reported occurrence of a laterite on the western margin of the basin and have assigned a Palaeocene age to them. According to Biswas (1965, 1971) the lateritic rocks originally comprised trap wash and volcano-clastic sediments deposited in a continental to supracontinental environment resting unconformably over the basalts. . He designated these rocks as Madh Series.

Mineralogy, chemistry and economic aspects of the selected deposits from different parts from Gujarat have been given by Talati in a number of communications (Talati 1966, 1968, 1970, 1980). Bhatt (1971) has provided some details of the laterite occurrence around Bhavnagar in Saurashtra.

To Sahasrabudhe (1964,1978) goes the credit of providing a detailed account of all the lateritic rocks of Gujarat. He investigated in detail the bauxite deposits associated with lateritic rocks of Kutch, Saurashtra and Mainland Gujarat.

According to him, the bauxite occurs in the zones of laterite that separate the Deccan lava flows and overlying Tertiary sediments. He has given the following stratigraphic sequence.

Sub-Recent & Recent	Sand dune, tidal flats, Rann clays, and alluvium
Lower Miocene	Gaj beds
Upper Eocene (?)	Laterite
Early Eocene to Late Cretaceous	Deccan lava flows

According to Sahasrabudhe (1978) laterites of Kutch and Saurashtra point to their formation by 'in situ' decomposition of bed rock viz. pyroclastic material ejected during the Deccan volcanic episode.

Valeton (1983) has considered the Gujarat laterites in the larger context of the total laterite occurrences of India. In her words, lateritic bauxites in India occur from Kashmir in the north, to Kerala in the south, and from Andhra Pradesh in the east to Kutch in the west. A reconstruction of Lower Tertiary shorelines show that most Indian occurrences are situated on Palaeocene or Eocene coastal plains. According to her in Kutch, the lateritic bauxites are developed in two distinct stratigraphic horizons, the older one belonging to the Palaeocene, the younger one to the Eocene. The older and major laterites are formed on the peneplained clastic sediments of the truncated Upper Bhuj Formation of Lower Cretaceous age (Biswas 1977) or on Trap Basalts (Upper Cretaceous to Palaeocene). The peneplained surface of the Bhuj Formation and the flow surface of

the basalt have a weak relief of a few metres. The preserved bauxite belts are a few hundred metres to several kilometres wide, and the alteration blanket is generally 10-20 m thick. The belts extend parallel to the Lower Tertiary shore line in Kutch and the belt continues south-eastwards around the Kathiawar peninsula following the northward indentation of the Gulf of Cambay; north of Ahmedabad it turns southward following roughly the outline of the west coast of India. The distribution pattern of lateritic bauxites resembles a string of pearls around the Deccan peninsula.

Valeton (1983) has emphasized the role of groundwater in element re-distribution during lateritization. Shukla et al (1983) have invoked two different paleo-environments for the Gujarat laterite-bauxite deposits : continental and marine. Nayak (1979) Considered the laterites of Kutch to be of Tertiary age. In a subsequent note published on the South Gujarat laterites Nayak et al. (1981) have interestingly considered these laterites to be of Pleistocene age. Obviously these authors are inclined for invoking two periods of lateritisation in Gujarat. Shah and Murty (1985), on the other hand, have considered some of the S.Gujarat laterites as reworked Tertiary laterites. Nayak & Shringarpure (1981) have reported gibbsitised exotic organic remains (? echinoderm spines) within Kutch laterite, and according to these workers the gibbsitisation indicated a syn-sedimentary depositional environment when the bauxite was being formed.

An important contribution towards the Gujarat laterite has come from Patel (1987) who has described the laterites of Kutch as comprising "a single residual Palaeocene alteration profile over Trap basalts; the bentonite and lateritic bauxites constituting a "alteration blanket" forming an elongate belt, hundreds of kilometers long, a few hundred meters to several kilometers wide running parallel to the Lower Tertiary shoreline". This author has postulated a genetic model which emphasizes role of groundwater and varying efficacy of sub-surface drainage producing lateral facies variation.

#### GENETIC ASPECTS

Genesis of lateritic/bauxitic rocks of Gujarat has been studied in two contexts. While Valetton (1983) has dealt with these rocks in a global perspective, aiming at presenting a universally applicable genetic model, the others (Rao, 1976; Sahasrabudhe, 1978; Talati & Jain, 1978; Nayak, 1979; Shukla et al, 1983 and Patel, 1987) have confined their observations to the Gujarat laterites only. Sahasrabudhe (1964, 1978) has made pioneering contribution to the problem of the genesis of Gujarat laterites. According to him, the laterites have been formed by 'in-situ' decomposition of pyroclastic material ejected during the Deccan volcanic episode. The typical and unusual tuffaceous appearance of the bauxite and the remnants of ashes in some laterites indicate the above genesis. The fawn grey massive high grade bauxites were regarded to be original tuffs subsequently bauxitised, whereas the gritty and conglomeratic types

represented a reworked and transported facies of earlier formed bauxite. Conditions favourable for lateritisation as visualised by Sahasrabudhe comprised (i) alternating wet and dry seasons with pronounced dry climates, (ii) tropical temperature, (iii) fluctuating water-table not far from the surface and (iv) gently sloping surface of the ground.

Rao (1976) has also attempted to explain the genesis of Gujarat laterites and bauxites. He considered the basaltic and some other supratrappean sediments as source rocks and derived laterite-bauxite sequences by processes operating on well-drained ridges, mounds and hillocks under warm humid rainfall conditions. He observed that some lateritic profiles were devoid of bauxite and instead a zone of kaolinite was present. To explain this, he has stated that while a crust of laterite was forming at higher levels, lower down on the slopes and in the valley simultaneously, kaolin was being formed since suitable drainage, conditions for bauxitization did not exist. He has also given an alternative explanation for the absence of bauxite and stated that "the later Tertiary sediments (Miocene) encroached upon these bauxite deposits. The water table rose and the leaching effects were reversed, resulting in kaolinisation and resili<sup>ci</sup>fication of these deposits, to some extent. This conversion of bauxite into kaolin resulted in an increase in volume that caused squeezing and flowage. Kaolin moved into cavities and other pore spaces in the bauxite. The irregular



lines of contact between the different layers of the bauxite profile, described earlier, is perhaps due to this reason."

Talati and Jain (1978) have invoked tectonism to explain the laterite formation in North Gujarat. They have reported lateritisation of rocks other than traps and tuffs, and have visualised role of a major NNW-SSE fault running east of Himatnagar and Baroda. Conditions conducive for the rock transformation in the past i.e. high rainfall, sloping ground and increased groundwater circulations were brought about by tectonism parallel to the above faultline.

According to Nayak (1979) who has dealt with the subject of Kutch the origin of laterites in some detail, the laterites and bauxites were the products of 'insitu' alteration of Deccan basalt and the prevailing conditions were (i) a tropical to sub-tropical continuously humid climate (ii) not very rugged topographic relief with gently sloping surfaces (iii) porous and permeable rock (iv) thick forests (v) pH of hydrolyzing system around 7.0 to 9.5 (vi) fluctuating water table such that the rocks were permanently above the water table and (vii) predominance of chemical weathering over the physical. Regarding the South Gujarat laterites, his genetic model is slightly different. He thinks that here the laterites originated due to 'in situ' alteration of a sedimentary clay; this clay was originally derived from the Deccan basalt.

Valeton (1979, 1983) has taken into account the laterite and bauxite of Gujarat to explain her genetic model. She has observed that the weathering crust of the eastern part of Gujarat is a normal Fe and Si rich laterite whereas the western part is much richer in Al and forms a high quality bauxite belt. She has highlighted the role of groundwater, emphasizing lateral movement of all major elements (Al, Si, Fe, Ti) leading to a lateral facies differentiation from a kaolinitic laterite to an Al-rich bauxite. She has quoted Goudie (1973) who has suggested that during uplift above the groundwater level, the Fe rich parts have formed hard ferricretes, whereas the Al-rich parts became hard alucretes.

Shukla et al (1983) have categorised the occurrences of Gujarat laterites into two types of environments, continental and marine. In their words : "In continental type, basalt/granite - altered zone-clay or without clay-laterite- aluminous laterite/bauxites are identifiable as successive stages of weathering sequence, whereas selective desilification<sup>ci</sup> and deferrification were the main process of bauxite formations in marine environment". These authors have also emphasized the role of groundwater, its pH and Eh conditions, the contrasting wet and dry climate and heavy rainfall as important factors. Their study brought out that by and large the bauxite deposits have been derived from basalt. The basalt sequence viz - altered basalt lithomarge with or without bentonite - laterite - bauxite is seen to indicate successive stages due to 'in situ' weathering.

Nowhere these authors encountered either pyroclastics altering into bauxite or bauxite associated with the limestone resembling karst type. Therefore, they have differed from the views expressed by Sahasrabudhe (1964) regarding the genesis of bauxite of Gujarat. Their opinion is that the continental environment is a well recognised setting for the formation of bauxites in the entire western region whereas marine environment is a peculiar feature in the region of Kutch.

The genesis of Kutch laterites has been explained by Patel (1987) by invoking a dominant role of groundwater, apart from the other usual factors. His genetic model involves both vertical and lateral differentiation of major elements due to high-level flowing groundwater. Varying efficiency of subsurface drainage has produced lateral facies variation. This led to formation of two types of sections, the high silica type with a bentonitic-kaolinitic saprolite (resulting in the formation of bentonite deposits), and low silica type with a kaolinitic saprolite.