CHAPTER - VIII

R E S U M E

RESUME

The present investigation has aimed at collecting all available information on the laterites of Mainland Gujarat and provide a comprehensive account of the various occurrences, their mineralogy and chemistry. The author has not only attempted to provide all possible information collected by him in the field and in the laboratory, but has also ventured to put forth a genetic model for these controversial rocks of Mainland Gujarat.

Genesis of lateritic/bauxitic rocks of Gujarat has been studied in two contexts. While Valeton (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. 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.

Laterite occurrences of the Mainland Gujarat, when studied individually in isolation, do not reveal much, but the synthesized information collected from all the localities, throws

valuable light on the question of the origin of laterite in general and of Mainland Gujarat in particular. On the basis of detailed field work and visits to the various reported and unreported occurrences, and a critical appraisal of bore hole data, the present author has been able to recognise almost all the horizons that are typical of a laterite sequence. He has observed that in all localities, the parent rock has been the Deccan basalts. Most of the exposed laterite sections are fragmentary, but at a few places, they do show reasonably good profiles, especially in N.Gujarat. In most occurrences, only 2 or 3 horizons could be ascertained. But the integrated picture is quite revealing, and the field data when considered along with the laboratory analyses of chemistry and mineralogy, has enabled the author to arrive at a number of important conclusions.

Field studies, have established that the intensity of lateritisation was not the same everywhere,Several exposures (Harsol-Sultanpur, Amliyara, Manjlau, Tarbhon, Khutai Mata) typically point to the fractures being an important controlling factor in advancing the process of lateritisation. Development of bentonite is somewhat erratic and appears to occur as lenses. Formation of bentonite zone has inhibited the development of bauxite, The kaolinite horizon, is developed all over. Bauxite horizon is discontinuous and appears to have formed as lensoid pockets, Lithomarge horizon is also discontinuous in the sense that at many places it is difficult to identify and demarcate it. Reworked laterite occurrences are easily identifiable. They do not follow the expected sequence. Various observations and inferences of the present study fit into the interpretation that the Box and B-horizons are derived by the 'insitu' chemical alteration of basalt.

Lateritisation of basalts, as is the case in the present study, involves the breakdown of minerals present in the parent rock, viz. calcic plagioclase (labradorite), augite, olivine and iron ores. The minerals present in various laterite profiles have been broadly classified into two categories :

(I) Neominerals :

a. Iron bearing minerals (Goethite, Lepidocrosite, Hematite and Maghemite).

b. Aluminium bearing minerals (Gibbsite, Boehmite, Halloysite, Kaolinite and Montmorillonite).

c. Titanium bearing minerals (Anatase and Rutile)

(II) Other minerals

a. Ankerite

b. Calcite

c. Quartz

The likely derivations of the various minerals is as under :

Minerals	Derived from	Environment
Goethite, Lepidocrosite Hematite and Maghemite	Augite, Olivine and Iron ores	Acidic (pH < 4)
Gibbsite and Boehmite	Plagioclase feldspar Augite	Acidic (4 < pH > 10)

Kaolinite and Halloysite	Plagioclase feldspar Augite and Olivine	Alkaline (pH > 9)
Montmorillonite	Plagioclase feldspar, Augite and Olivine	Alkaline (ph > 10)
Anatase and Rutile	Titanaugite and Sphene	Acidic (pH < 5)
Ankerite	Augite, Plagioclase feldspar, Olivine and Iron ores	Alkaline (pH > 9)
Calcite	Augite and Plagioclase feldspar	Alkaline (pH > 8)
Quartz	Quartz	Alkaline (pH > 9)

A decrease in proportion of silica in laterite zone (Box) as compared to the parent rock is consistently seen in all localities. The trends of variation in the major constituents of laterites in all profiles from North to South Gujarat, shows the following characteristics :

i. Decrease of SiO_2 towards the laterite zone

ii. Increase of Al_2O_3 in the kaolinite, bauxite and lateritic bauxite horizons.

iii. Gradual decrease in Fe_2O_3 in saprolite zone and enrichment in the top horizons viz., bauxitic laterite, unindurated laterite and duricrust.

iv. FeO behaves identical to that of Fe_2O_3 in all the profiles.

v. Gradual increase of TiO_2 upward in the profile and enrichment in unindurated laterite and duricrust horizons.

vi. Enrichment of CaO in kaolinite and topmost portion of laterite zone.

vii. Depletion of MgO in laterite zone and its enrichment in bentonite horizon near the base.

viii. Depletion of Na_2O and K_2O in laterite zone and their enrichment in saprolite zone.

ix. Gradual increase of L.O.I. values in saprolite zone upto lateritic-bauxite contact and then a decrease further upwards.

So far as the trace elements are concerned, all of them, by and large, show identical behaviour. The ratios of concentration or depletion for each element have been obtained and they point to an initial increase in the transitional zone, then the values go down towards lithomarge, and finally increase in the laterite horizon.

The lateritic rocks of the study area appear to have originated by processes wherein the groundwater played a dominant role, bringing about rearrangement of constituents into well-defined horizons in a subaerially weathered basalt. Two main additional factors that have been need be highlighted are those of (i) the nearness of a shoreline and (ii) fracturing of the parent rock.

For the solution, migration and precipitation of major and trace elements within the laterite, the groundwater conditions required are (1) net flow towards the sea, (2) groundwater levels must be high and oscillatory in nature and (3) Eh conditions must be reducing, for solution and migration of elements.

The Eh-pH of the groundwater involved in the lateritisation process was important. The process of leaching (solution and migration) and of precipitation (deposition), mostly brought about by fluctuating groundwater and changing Eh and pH values.

Alkalinity of groundwater could be due to two factors. Under certain conditions, high pH values could result due to its reactions with rock minerals on account of replacement of metal cations by hydrogen ions from water. Secondly, the percolating water from above carried with it the required substances like Cl^-, Na^+, SO^{2-}, Mg^{2+}, Ca^{2+}, K^+ etc. adding to the alkalinity of the groundwater. The increased alkalinity of groundwater could also be due to nearness of the sea, either by a direct contamination with sea water or solution of blown salt in the percolating rain water. Acidity (low pH) is attributed to the presence of organic acids mainly humic and fluvic acids, these being products of plant decay. Groundwater pH may also be affected by the nature of individual rocks - the more acidic type liberating more silica to give an acid reaction. Variations in pH also occur with depth, the value tending to increase downward

The laterite rocks, originating from the Deccan basalts, show following chemical-mineralogical transformations.

1. Kaolinization of Al-Si bearing minerals;
2. Formation of Fe oxides from Fe containing minerals;
3. Formation of Al hydroxides by incongruent dissolution of Kaolinite minerals (occasionally also directly from feldspar, etc.);
4. Congruent dissolution of kaolinite minerals;
5. Dissolution of quartz.

The entire phenomenon of transformation of basalt into laterite comprised several stages through which a subaerially weathered rock passed, to finally emerge as a laterite sequence. The various stages of lateritisation comprised :

1. Weathering of basalt under tropical conditions
2. Rise of the water table to the surface
3. Hydrolysis of the minerals
4. Lateral movement of groundwater
5. Enrichment of Al and Fe in the upper portion (Box), followed by precipitation and duricrust formation

On Mainland Gujarat, the various laterite occurrences follow a trend which coincides with a major NNE-SSW lineament, located on the eastern flank of the Tertiary Cambay basin. Significantly, only such basaltic rocks that were located along this fault got lateritized. The control exercised by this tectonic feature is manifest in many ways. When viewed in a larger perspective, the lateritisation appears to be a Paleocene phenomenon related to the major rifting of India's western continental margin and its subsequent NE ward drift.