ABSTRACT

The bauxite deposits of Andhra Pradesh and Orissa of India are termed as East Coast Bauxite (ECB) by virtue of their proximity to the eastern coast of India. The Panchpatmali bauxite deposit (area of study) is located at Koraput district, Orissa between North lattitudes $18^{\circ}48'$ to $18^{\circ}54'$ and East longitudes $82^{\circ}57'$ to $83^{\circ}04'$ (Survey of India toposheet no. 65J/13 and 65N/1) forms a part of ECB.

The bauxite deposit in Panchpatmali area developed in-situ over khondalite parent rock, preserving the primary structures with an age of Palaeocene to Eocene. The outcrop occur as elongated linear body, extending along the trend of foliation and is partly covered by soli and/or laterite of varying thickness.

Geomorphological studies from satellite imagery and aerial photographs show four dominant physiographic levels, in which the topmost one is covered by laterite/bauxite blanket. Lineaments follow the general trend of NE - SW with minor cross lineaments in NW - SE direction. Different order of streams follow the depressions along the trend of lineaments without any genetic relevance, implying tectonic stability of the area at least in Tertiary - Quaternary period. In the absence of any tectonic disturbances, the different physiographic levels are attributed to a single planation phase and the presence of insitu breccia at the top of bauxite column is assigned to solutional activity followed by roof collapse.

The fabric of different components of bauxite column shows the pores present in saprolite and bauxite are in the form of micro tube and void, lying parallel and some times perpendicular to the primary schistosity and are partially to fully filled by secondary minerals. Macro-skeletons of the primary structures are preserved, whereas, micro structures are completely obliterated and replaced by neoformed textures. Neoformed textures include pore spaces, colour banding, vesicular texture, scoriaceous texture etc.

Mineralogically, the bauxite column shows the presence of relics of feldspar, garnet, sillimanite, quartz, zircon etc. Neoformed

minerals include gibbsite, kaolinite, goethite, hematite and traces of anatase. Gibbsites present are of different forms, ranging in size from 10 to 70 μm. These are developed directly from parent minerals or deposited from solution as euhedral crystals. Kaolinites are highly disordered in nature and shows high concentration in saprolite and brecciated zone. These are developed due to resilication of gibbsite via allophane phase as evidenced by XRD, IR, DTA and SEM studies. The sharp boundary between bauxite and saprolite, nature of ordering in kaolinite and fabric relationships marks the secondary nature of saprolite, developed after bauxite due to ground water table fluctuations.

To get an idea about the present day weathering processes operating at the same area, ground water samples and weathered samples below the water table are studied. Ground waters are feebly acidic with positive oxidation potential which can transform Fe^{2+} to Fe^{3+}. Relative mobility of Al is nil, Fe low and Mg, Ca, Na are high, which are important for development of hydrated aluminium silicates and iron oxide/hydroxide. Plotting of different cations, silicic acid and pH shows the ground water at present are primarily capable of kaolin group of minerals development. Investigation on recent weathered samples by XRD, IR and SEM shows abundance of kaolins rather than gibbsite.

Geochemically, SiO_2 shows sharp increase in the saprolite zone, where as, TiO_2 and Al_2O_3 remains almost constant throughout the profile . Fe_2O_3 shows in general a decreasing trend with depth except the upper brecciated zone. MgO, MnO, Na_2O and K_2O shows sharp increase in the basal part and slightly increased in the lowest level. Bulk chemical ratio implies relative concentration of Fe_2O_3 and Al_2O_3 with respect to parent rock.

Behaviour of different trace elements are quite contrasting in nature. Co shows positive correlation with Fe, where as V and Cr show negative correlation. Ni and Zn are depleted in the weathered column having positive correlation with Mn. Zr shows positive correlation with Ti.

REE shows mobilisation and fractionation in the weathering profile. The increase of REE concentration with depth implies its mobilisation, where as, difference in LREE / HREE with depth signifies fractionation. Higher concentration of LREE at clay rich zone are attributed due to the presence of kaolinite, which accomodates these.

Thermodynamic models at 25^{o}C temperature and 1 atm. pressure for K-feldspar, garnet and sillimanite are developed. These models suggest that K-feldspar can alter directly to gibbsite if the solution has > $10^{-5.19}$ H_4SiO_4 and $K^+/H^+ > 10^{-8.3}$, garnet can alter to gibbsite from 5.5 pH and + 0.13 V onwards, whereas, sillimanite can develop gibbsite under both acidic and alkaline conditions with higher silica activities. Implication of these models on the development of Panchpatmali bauxite are also discussed in this chapter.

All of the above studies reflect a complex alteration process responsible for the development of Panchpatmali bauxite. Development of neogene minerals under different environmental conditions which are responsible for the development of this deposit are focussed in this chapter. From the discussion different alteration stages are proposed for Panchpatmali bauxite, These include, pre-bauxite stage , syn-bauxite stage and post bauxite stage.

Pre- bauxite stage is marked by development of different physiographic levels after the onset of monsoonal climate at Tertiary.

During syn- bauxite stage, alkaline pH and rapid drainage conditions convert parent minerals (feldspar, garnet and sillimanite) directly to gibbsite with high loss of silica, alkali and alkaline earth elements and relative concentration of Al_2O_3, Fe_2O_3, TiO_2.

Post- bauxite stage is marked by development of in-situ breccia at the top due to collapse of former porous structure. This promotes water logging condition at top leading to the development of kaolinite and goethite. At the base of profile, ground water resilicates gibbsite, developing a clay-rich horizon (saprolite). Mobilisation of trace elements and REE are mostly confined to this stage.