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Hyper Spectral signature and Geochemical study of Eastern ghat Bauxite in the part of Kollimalai, Namakkal District, Tamil Nadu,India.

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ABSTRACT

Bauxite is a rock consisting mainly of aluminum hydroxide minerals; it is the major source of alumina ($A1_2O_3$) from which aluminum metal is smelted by electrolytic process. Bauxite occurs in Kolli hill along the Eastern Ghat range of Tamil Nadu, Which essentially consists of the charnockite and the associated rocks of the Archaean age. It is formed due to residual weathering and lateritization of Archaean charnockites. In the Study area Bauxite is soft, whitish red to brown aluminum ore mineral mainly consist of hydrous aluminum oxides and aluminum hydroxides. Laterites are mostly found in humid tropic climatic condition due to intense weathering of host rock. Most authors agree that bauxite forms by weathering under conditions favorable for the retention of alumina and the leaching of other constituents from the host rock. From the above literature review aim of the present work is to study the occurrence of bauxite in Kolli hills in Namakal District of Tamil Nadu. Objectives are to study ore petrography of Bauxite and XRF study to get weight percentage of oxide ores. Inthefield observation, a sharp contact between brownish red laterite at the top followed by pinkish white Gibbsite as Bauxite ore at the bottom and further underlined by lithiomorphs due to basement weathering. From Petrographic study, it is possible to identify the constitute of Gibbsite occurrence with pale brown colour, weak pleochroism and moderate relief as main Aluminous ore mineral and Goethite as opaque luster, whitish blue colour with imperfect cleavage and ubiquitous due to residual weathering of above aluminous ore from Charnockite basement. Microscopic study also shows the brownish yellow colour, Oolitic structure and weak pleochroism for Diaspore ore. Deep brown colour and opaque luster without any structure can be identified as pisolitic Cliachite. It is characterized byOffset of Spectral Plot of laterite with 72 % absorption at 2.21 micro meters wavelength as laterite from sellurnadu of Kolli hill and very high Fe_2O_3 constitute of 83% by weight, low Al_2O_3 of 14 % & 0.36 % of TiO_2 portrays it as Iron rich laterite at Selurnadu.It is also characterized by Spectral Signature of Bauxite with 80 % absorption at 2.27 micro meters wavelength in village Ariyurnadu with medium Al_2O_3 of 39.67 %, medium high Fe_2O_3 concentration of 55.32 % & 1.61 % of TiO_2 by weight conveys it as low grade bauxite (aluminous laterite) in the above location. 86 % absorption confirms its association with Fe_2O_3 Iron ore at 0.91 μ m, Low Al_2O_3 % of 25.73, high Fe_2O_3 concentration of 71.58 % & 0.23 % of TiO_2 weight indicates it could be classified as lateritic bauxite at Thinnanur. Above geochemistry reveals about the site specific ore percentage of Bauxite within study area kolli malai.

KEY WORDS: Petrography, Geochemistry, Bauxite, laterite, gibbsite, oolites &Kollimalai.

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INTRODUCTION

Bauxite is a rock consisting mainly of aluminum hydroxide minerals. It is the principal source of alumina ($A1_2O_3$) from which aluminum metal is smelted by an electrolytic process. Both bauxite and alumina are also used for several products other than metal. The name "bauxi" was proposed by Dufrenoy in 1845 (Bracewell, 1962, p. 8) for a material occurring near Less Beaux, France, that had been found to consist mainly of a mixture of hydrated aluminum and red iron oxides. The term was later changed to "bauxite" to conform a change in spelling of the type locality. Bauxites composed chiefly of the mineral gibbsite and commonly termed as "trihydrate bauxites" or "the Suriname type"; those composed of boehmite are "monohydrate bauxite" or the "European type"; those composed of a mixture of gibbsite and boehmite are called "mixed bauxites." The term "Jamaica type" is applied to very fine grained high-iron gibbsitic bauxite containing minor quantities of boehmite.Bauxite is the only ore of aluminium,it is an amorphous or clay like substances, the colour of Bauxite is pink but with tin impurities to became brownish. It shows oolitic and pisolitic structures. It`s hardness is variable but has a low specific gravity of about 2.6 composition is $A1_2O_3$. Bauxite forms a part of Kolli hill in the Eastern Ghat, range, of Tamil Nadu, Which essentially consists of the charnockite and the associated rocks of the Archaean age (Roy Choudhury 1955). Charnockite is the major rockwhich ismostly composed of Quartz, feldspar and hypersthene.The bauxite is formed by residual weathering and lateralization of Archean charnockites. The residual Bauxite directly overlies the charnockite group of rocks(Rao & Raman 1979). The Bauxitization has been a prolonged process of weathering and the process is not completed in some parts of the Plateau due to differential leaching by surface/surface drainage system in the tropical climate.The Bauxite is the primary ore of alumina and used in cement industry and also used as abrasives depending on the grade of the ore. In the Study area Bauxite is a soft, whitish red to brown aluminum ore mineral mainly made up of hydrous aluminum oxides and aluminum hydroxides and laterites are mostly found in humid tropical climatic condition due to intense weathering of bed rock.

ORIGIN OF BAUXITE

Geologists have been interested in the origin of bauxite for more than a century and although many theories have been proposed, many problems remain unsolved. Older theories include those that bauxite formed by (1) precipitation from hot waters rich in aluminum salts, (2) alteration of aluminous parent materials in seawater, (3) deposition of aluminous materials in lakes, and (4) leaching of aluminous rocks by naturally evolved acid. Most authorities now agree that bauxite forms by weathering under conditions favorable for the retention of alumina and the leaching of

other constituents from the parent rock. The weathering processes that alter rock are active within the zone of influence of the atmosphere, hydrosphere and biosphere. The processes are classified into chemical and mechanical groups. In chemical weathering, reactions take place with the parent rock that generally remove the more soluble components and add hydroxyl (OH) groups, oxygen or carbon dioxide to the less soluble ones. Descending surface water is clearly the principal agent of chemical weathering. Living and decaying vegetation and bacteria affect the chemistry of water and elements leached. Mechanical weathering includes the breaking up of deposits, caused by penetrating roots and by alternating expansion and contraction due to solar energy.

STUDY AREA

The Bauxite forms a part of the Namakkal district of Tamil Nadu and is bounded by latitudes 11 °10' to 11° 25'N and longitudes 78 °15' to 78 °25'E (Fig.1) covered by Survey of India(SOI)Topographicsheets 58I/7&8. Aluminous laterite occurs as capping over the charnockite rock at high altitude between 1148m to 1386m above Mean Sea Level (MSL). Study area kollimalai is situated north of Namakkal town and forms a part of the southern extension of the Eastern Ghats.From the Field observation a sharp contact between brownish red laterite at the top followed by pinkish white Gibbsite as Bauxite ore at the bottom further underlined by lithomorphs as basement weathering is observed with following lithostratigraphy (Fig. 2).

Charnockite → Altered Charnockite → Lithomorph Clay → Laterite → Aluminous Laterite → Bauxite (Cap rock) (Fig. 2)**.**

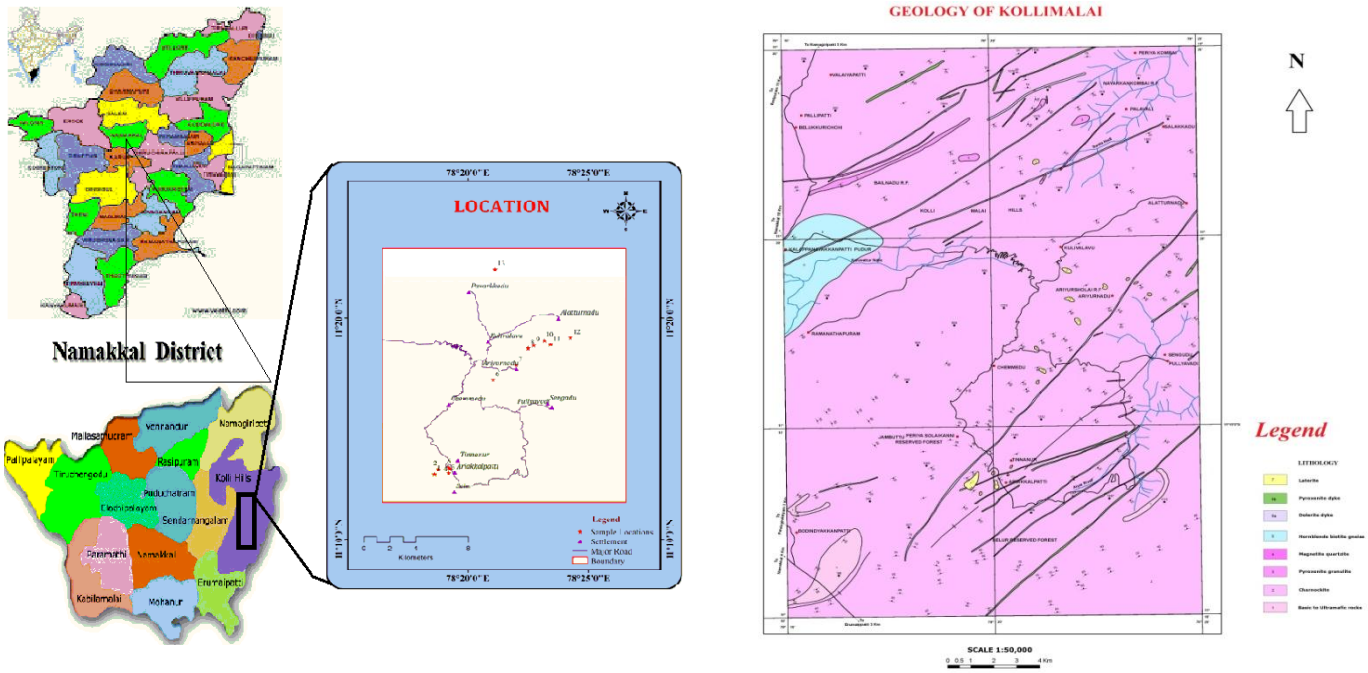


Fig.1.Study Area Location and geology map of study

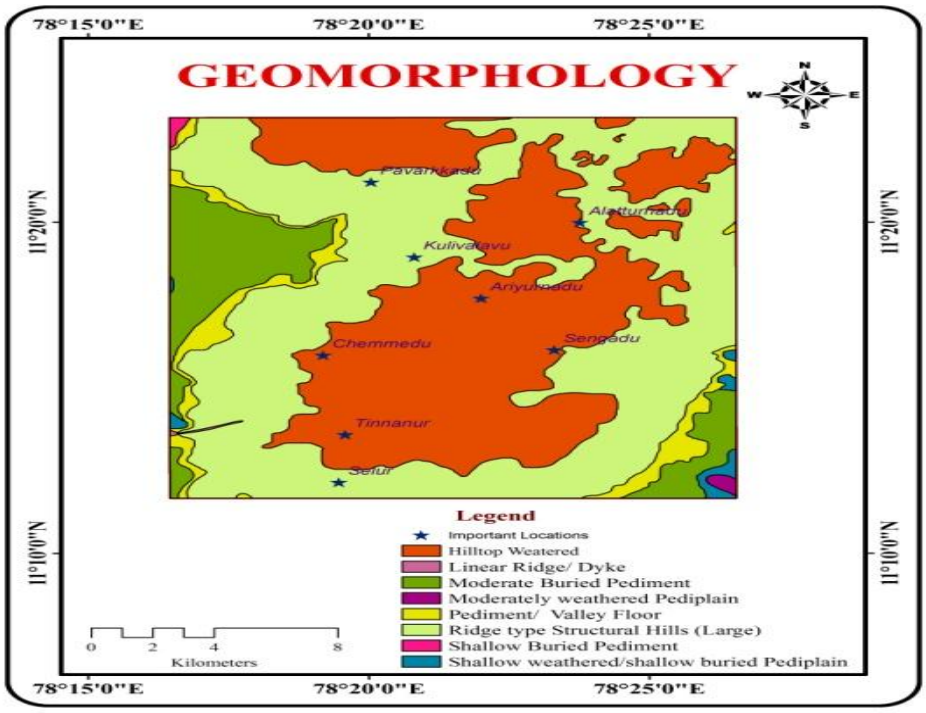
GEOLOGY OF THE STUDY AREA

The study area Kollimalai forms a part of the Archean peninsular complex having intensive high grade regional metamorphism with folding, faulting and shearing structures. The major rock types includes garnetiferous acid charnockite, epidote-hornblende gneiss with lenticular bands of magnetite quatzite, pyroxenite and pyroxenegranulitestrending in NE to ENE-WSW directions which in turn are cut by long NE-SW trending dolerite dykes extending to more than 10km in the strike length. The laterite which occurs as capping over acid charnockite is dark brown in colour and is seen as streaks and pockets(Fig.1). The lateritisation and alteration of charnockite, which still carries faint structural features of the parent rocks. The other variety is detritus variety, formed from breaking up of the former and is spread along the slopes of the hills. The length of the capping range from 100m to a maximum of 725m width from 40m to 250m and thickness 8 to 11m. The process of lateralization must have been a more recent phenomenon and much later to the structural deformation under sub-aerial weathering and alteration of charnockite group of rocks of Precambrian age. Originally the lateritisation may have prevailed extensively and the present capings may be the erosional remnants and may be related to surface of peneplanation of bauxite deposits in India including Tamil Nadu are related to the world wide bauxite formations during the Eocene period (S. Ramadurai et.al., 1966; G. Mani et.al., 1975).

Fig.2.Alluminous lateriticBauxite of Kollimalai in Ariyurnadu, Whitish pink – Gibbsite, Brownish red –Laterite

GEOMORPHOLOGY

In recent years the increasing use of satellite remote sensing has made easier to define the



spatial distribution of geomorphology and other associated land form features. The delineation of the geomorphic units is based on interpretation of remote sensed data as well as observations made in the field. The present day landforms are irregular outlines of various geomorphic processes operating in the study area with ongoing geologicandtectonic process operating below the earth surfaces. The rate of deposition and erosion isever being uniform which causes uneven topographic outcropping patterns in the surface. By carefully analyzing various outcrop patterns with the help of IRS satellite imageries, the,characteristic land form recognized are followed by various landforms present in the study

Fig.3.Geomorphology map of study area

1. Weathered crown along Hill top (caps), 2. Linear Ridge / dyke,3. Moderately burried pediments, 4. Moderately weathered pediplain, 5. Pediment/ valley floor, 6. Ridge type structural hills (large), 7. Shallow buried pediment, 8. Shallow weathered/ shallow buried pediplain(Fig.4).

PETROGRAPY

From the kollimalai seven samples were collected from various exposed out crops of bauxite. The fresh samples were selected for preparation of micro sections for mineral identification studies. Under thin section, these are shown as Gibbsite, Diaspore, Cliachite, and Goethite and feldspar mineral assemblages. The constitution of Gibbsite with pale brown colour with weak pleochroism and moderate relief as main Aluminous ore mineral and Goethite with opaque to sub vitreous luster, whitish blue colour, imperfect cleavage and ubiquitous due to residual weathering of aluminous ore

from charnockite basement(Fig. 4). The brownish yellow colour, Oolitic structure and weak pleochroism as Diaspore.

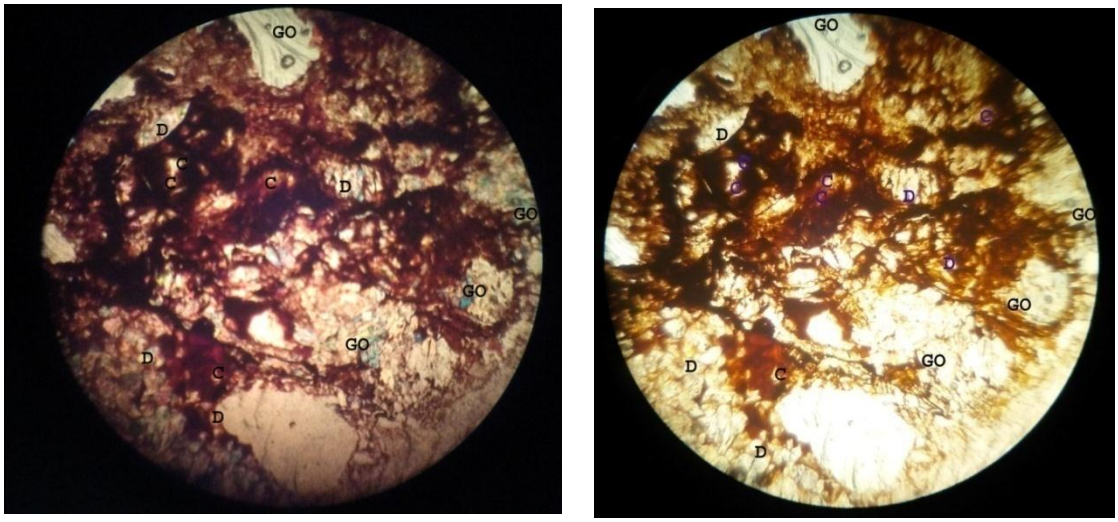


Fig.4.

D – DIASPORE, Brownish Yellow, Oolitic Structure, Weak pleochroism.

GO–GOETHITE, Whitesh blue, transparent on edge, grey in Reflectedlight.

C – CLAIACHITE, Deep brown, opaque, pisolitic massive, no structure.

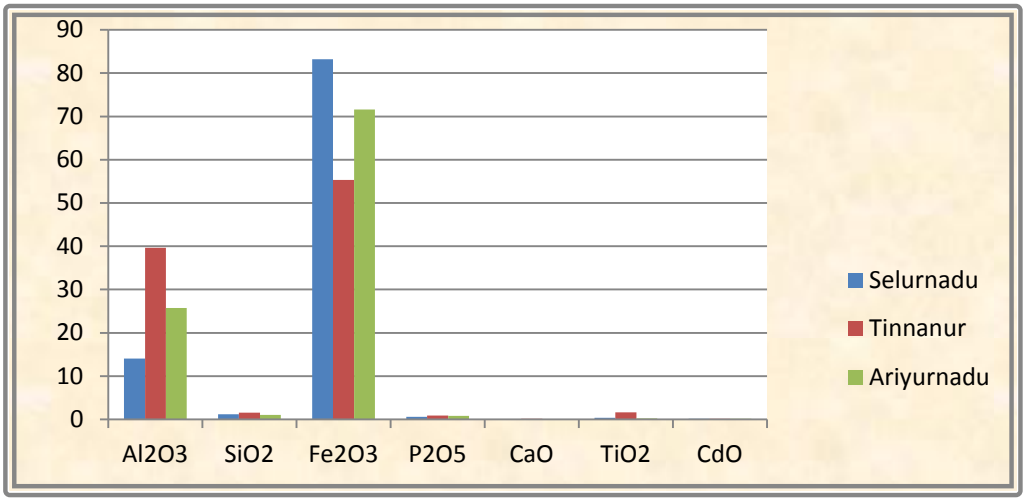


Fig.5. Bar Digram of Al_2O_3 – Fe_2O_3 Concentration

ROCK CHEMISTRY

Sampling and Analytical techniques

Seven samples of bauxite from kollimalai in namakkal district were collected. Around 4 thin sections were prepared and studied. Major oxides compositions were analyzed for 3 samples using X-ray fluorescence spectrometry(XRF) at the CSIR Lab, Thiruvanthapuram. The major oxides include SiO_2, Al_2O_3, Fe_2O_3, MnO, MgO, K_2O, Na_2O, TiO_2 and P_2O_5.The major oxides, (Table.1) Fe_2O_3, Al_2O_3, NiO, CuO, BaO are having concentration values then other elements ZnO, SiO_2, P_2O_5, CaO, Sc_2O_3, Ga_2O_3& Re. Here Fe_2O_3 iron rich bauxite like laterite has more weight % than aluminous laterite (Al_2O_3). Other gangue minerals like CuO, ZrO_2& PbO are found to be appreciable in PPM concentration from this residual bauxite developed from charnockite source. It is characterized by very high Fe_2O_3 constitute of 83% by weight, low Al_2O_3 constitute 14 % conveys it as a low grade bauxite (laterite) &0.36 % of TiO_2 portrays it as Iron rich laterite at Selurnadu (Table.1, Fig.5). It is also characterized by medium Al_2O_3 of 39.67 weight %, medium high Fe_2O_3 concentration of 55.32 %& 1.61 % of TiO_2 by weight conveys it as a medium grade bauxite (lateritic bauxite) at Thinanur. Low Al_2O_3 weight % of 25.73, high Fe_2O_3 concentration of 71.58 % & 0.23 % of TiO_2 by weight conveys it as medium low grade bauxite (aluminous laterite) at Ariyurnadu. Above geochemical data reveals about respective site specific Al_2O_3 percentage of Bauxite within study area kolli malai (Table.1, Fig.5).

Table.1.Absorption Spectra (%) of *Bauxite Samples*&*XRF Data* relating Al_20_3 weight %

Absorption	72	86	80	in %
Bauxite	laterite	Low grade Bauxite	Latritic Bauxite	grade
Oxides	Selurnadu	Ariyurnadu	Tinnanur	Weight%
Al_2O_3	14.023	39.66	25.727	%
SiO_2	1.178	1.54	1.075	%
P_2O_5	0.624	0.87	0.795	%
CaO	0.114	0.128	0.106	%
TiO_2	0.356	1.606	0.227	%
Fe_2O_3	83.165	55.32	71.58	%
CuO	211.1	139.6	245.1	ppm
Rb_2O	0.121	91.8	0.1	%
ZrO_2	284.2	541.7	46.5	ppm
CdO	0.17	0.153	0.156	%
PbO	269.5	166.2	119.5	ppm

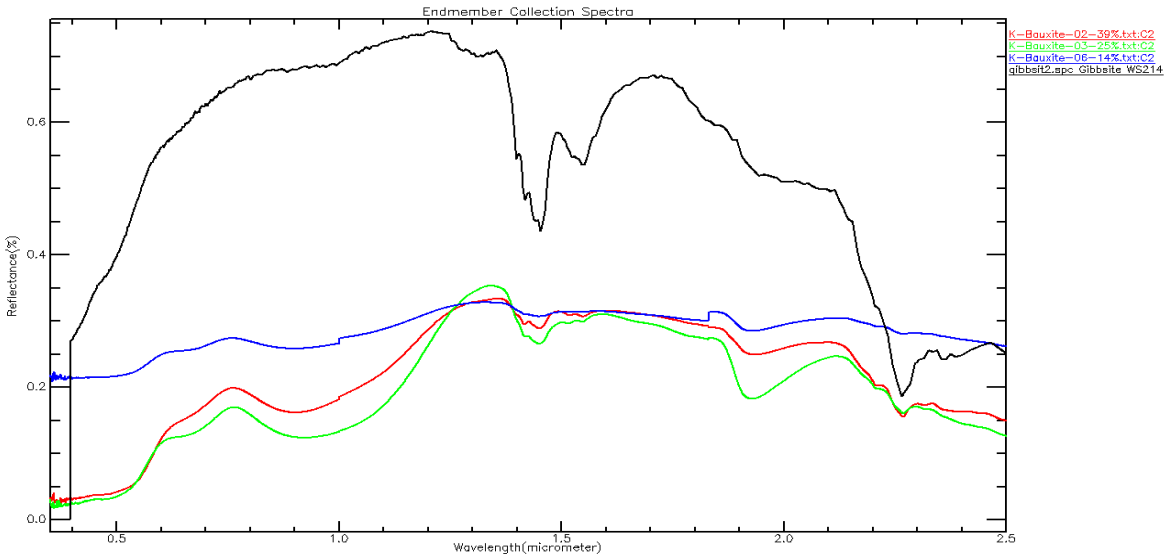


Fig.6. ASD Lab Spectral signature of Kollimalai bauxite.

The laboratory spectra of Bauxite especially for the diagnostic absorption signature at 2.26µm help in clarifying the Bauxite enrichment map (Arindam Guha et, al. 2012). Spectral Absorption peak of 86 %at 2.27 µm in wavelength at village Ariyurnadu with Al_20_3 weight % of 39.7 could be characterized as low grade bauxite. Spectral Signature of Bauxite with 80 % absorption could be classified as lateriticbauxitein location Tinnanur with Al_20_3 % of 25.73& 86 % absorption confirms its association with Fe_2O_3 Iron ore at 0.91µm. Offset of Spectral Plot of laterite with 72 % absorption at 2.21 µm wavelength has been characterized as laterite from selurnadu of Kolli hill with Al_20_3 of 14%.

CONCLUSION

By Petrography study, it is possible to identify the constitute of Gibbsite occurrence with pale brown colour with weak pleochroism and moderate relief as main Aluminous ore mineral and Goethite with opaque lusture, whitish blue colour with imperfect cleavage and ubiquitous due to residual weathering of above aluminous ore from Charnockite basement. From the Field observation a sharp contact between brownish red laterite at the top followed by pinkish white Gibbsite as Bauxite ore at the bottom further underlined by lithiomorphs as basement weathering is observed. Microscopic study also shows the brownish yellow colour, Oolitic structure and weak pleochroism for Diaspore ore. With deep brown colour and opaque lecturewithout any structure can be identified as pisolitic Cliachite. It is characterized byOffset of Spectral Plot of laterite with 72 % absorption at 2.21 micro meter wavelength as laterite from Selurnadu of Kolli hill, very high Fe_2O_3 constitute of 83% by weight, low Al_2O_3 of 14 % & 0.36 % of TiO_2 portrays it as Iron rich laterite at Selurnadu (Table.1, Fig.6). It is also characterized by Spectral Signature of Bauxite with 80 % absorption with medium Al_2O_3 of 39.67 %, medium high Fe_2O_3 concentration of 55.32 % & 1.61 % of TiO_2 by weight conveys it as low grade bauxite (aluminous laterite) in location Ariyurnadu. 86 % absorption confirms its association with Fe_2O_3 Iron ore at 0.91 μ m, Low Al_2O_3 % of 25.73, high Fe_2O_3 concentration of 71.58 % & 0.23 % of TiO_2weight indicates it could be classified as lateritic bauxite at Thinnanur. Above geochemistry reveals about the site specific ore percentage of Bauxite within study area kolli malai.

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