

# Petrography and Geochemistry Study of Bauxite in the part of Kollimalai in Namakkal District, Tamil Nadu

<sup>1\*</sup>SanthaKumar.K, <sup>2</sup>Aravindan.S, <sup>3</sup>Bharathiraja.S

<sup>1,2,3</sup> Dept. of Earth Sciences, Annamalai University, Annamalai Nagar – 608 002, India

\*Author:geosanthakumar@gmail.com

---

**Abstract:** Bauxite is a rock consisting mainly of aluminum hydroxide minerals; it is the principal source of alumina ( $Al_2O_3$ ) 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 Achaean age. It is formed due to residual weathering and lateritization of Archean charnockites. In the Study area Bauxite is soft, whitish red to brown aluminum ore mineral mainly consist of hydrous aluminum oxides and aluminum hydroxides and 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 occurrence of bauxite in Kolli hills in Namakkal District of Tamil Nadu. Objectives are to study ore petrography of Bauxite and XRF study to get weight percentage of oxide ores. In 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. From Petrographic 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. 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 by 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.7). 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 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 indicate it as medium low grade bauxite (aluminous laterite) at Ariyurnadu. Above geochemistry reveals the site specific ore percentage of Bauxite within study area kolli malai.

**Keywords:** Petrography, Geochemistry, Bauxite, laterite, gibbsite, oolites & Kollimalai.

---

## 1. INTRODUCTION

Bauxite is a rock consisting mainly of aluminum hydroxide minerals. It is the principal source of alumina ( $Al_2O_3$ ) 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 Les 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  $Al_2O_3$ . 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 Achaean age

(Roy Choudhury 1955). Charnockite is the major rock which is mostly 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 & P. S. 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 (Ali Asghar Nazeri., 1999). 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.

## 2. 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 of 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.

## 3. STUDY AREA

The Bauxite forms a part of the Namakkal district of Tamil Nadu and is bounded by latitudes  $11^{\circ} 10'$  to  $11^{\circ} 25'$  and longitudes  $78^{\circ} 15'$  to  $78^{\circ} 25'$  (Fig.1) covered by Geological survey of India Toposheets 58 I/7&8. Aluminous laterite occurs as capping over the charnockite rock at high altitude between 1148 to 1386m above MSL. Study area of kollimalai range 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 lithiomorphs as basement weathering is observed with following lithostratigraphy (Fig. 3).

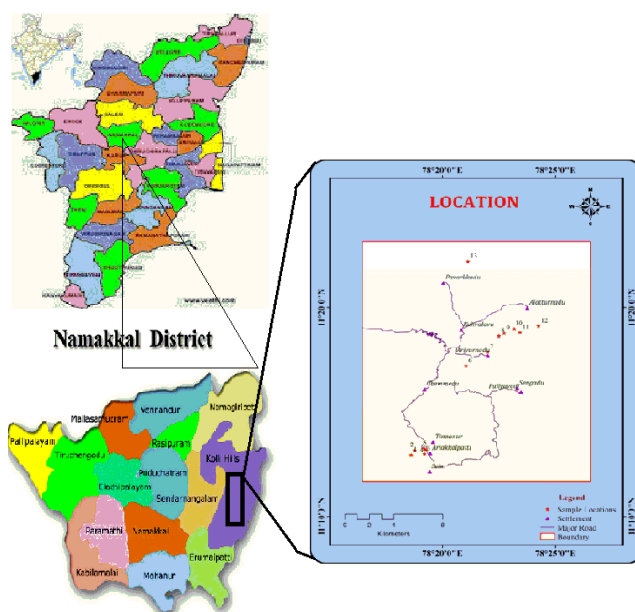


Fig 1: Study Area Location

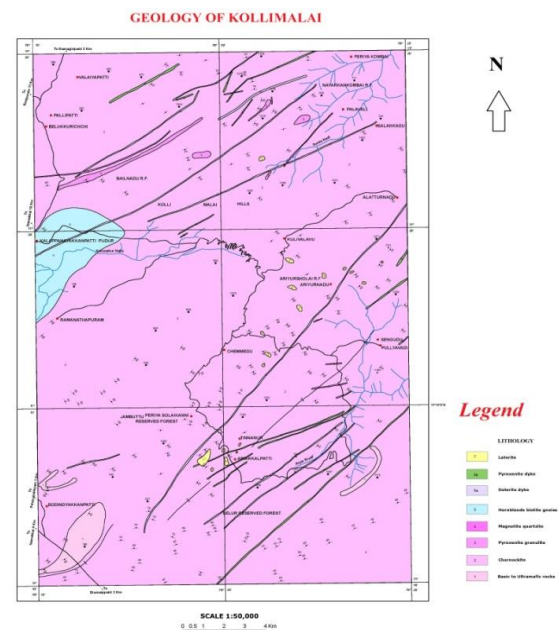


Fig 2: Geology of the study Area

#### 4. 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 include for garnetiferous acid charnockite, epidote-hornblende gneiss with lenticular bands of magnetite quartzite, pyroxenite, and pyroxene granulite trending in NE to ENE-WSW directions which in turn are cut by long NE-SW trending dolerite dykes extending to more than 10 km 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 .2). 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 100 m to a maximum of 725 m width from 40 to 250 m 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, 1968; G. Mani et al, 1975).

*Charnockite → Altered Charnockite → Lithomorph Clay → Laterite → Aluminous Laterite → Bauxite (Cap rock)* (Fig. 3).



Figure 3: Aluminous laterite Bauxite of Kollimalai in Ariyurnadu, Whitish pink – Gibbsite, Brownish red –Laterite

#### 5. 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 geologic and Tectonic process operating below the earth surfaces. The rate of deposition and erosion is ever 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 area, 1. Weathered crown along Hill top (caps), 2. Linear Ridge / dyke, 3. Moderately buried 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).

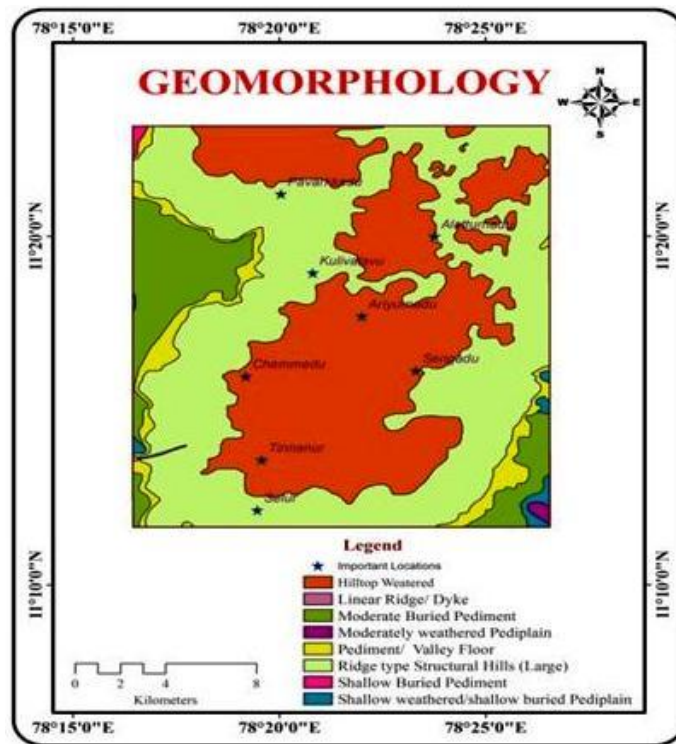


Fig 4: Geomorphology

## 6. PETROGRAPY

From the kollimalai seven samples were collected from various exposed outcrops 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, Claiachite, 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. 5). The brownish yellowish colour, Oolitic structure and weak pleochroism as Diaspore. Whitish blue colour to grey in reflecting light with transparent along edges can be identified as Goethite and of with deep brown colour and opaque luster with no structure as pisolitic Claiachite (Fig. 6)

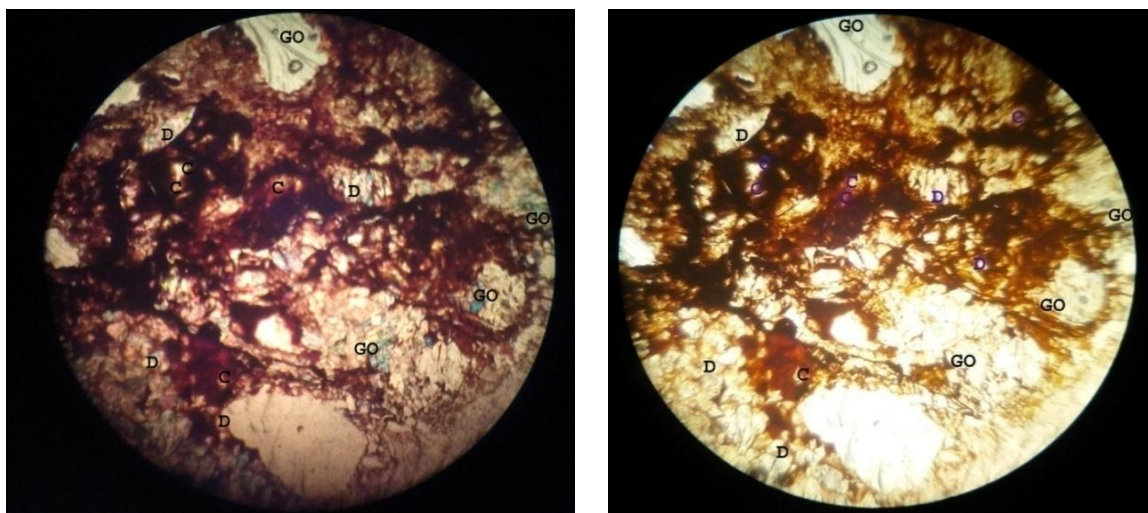


Figure. 5

D – DIASPORE, Brownish Yellow, Oolitic Structure, Weak pleochroism  
 GO – GOETHITE, Whitish blue, transparent on edge, grey in Reflect light  
 C – CLAIACHITE, Deep brown, opaque, pisolitic massive, no structure.

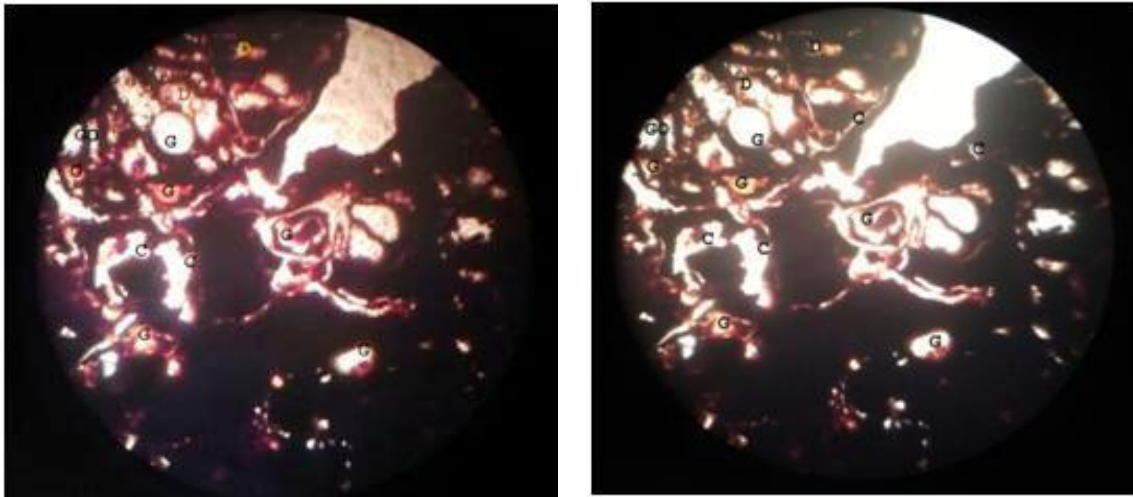


Figure. 6

- D – DIASPORE, Yellow colour, Oolitic Structure, Weak Pleochroism  
 GO – GOETHITE Whitesh blue, opaque, cleavage on (100) Plane  
 C – CLIACHITE, Deep brown, opaque, Absence of Xlline Structure  
 G – GIBBSITE, Pale brown, weak Pleochroism, Moderate relief

## 7. ROCK CHEMISTRY

### 7.1 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  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{MnO}$ ,  $\text{MgO}$ ,  $\text{K}_2\text{O}$ ,  $\text{Na}_2\text{O}$ ,  $\text{TiO}_2$  and  $\text{P}_2\text{O}_5$ . The major oxides, (Table.1)  $\text{Fe}_2\text{O}_3$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{NiO}$ ,  $\text{CuO}$ , and  $\text{BaO}$  are having concentration values then other elements  $\text{ZnO}$ ,  $\text{SiO}_2$ ,  $\text{P}_2\text{O}_5$ ,  $\text{CaO}$ ,  $\text{Sc}_2\text{O}_3$ , and  $\text{Ga}_2\text{O}_3$  &  $\text{Re}$ . Here  $\text{Fe}_2\text{O}_3$  iron rich bauxite like laterite has more weight % than aluminous laterite ( $\text{Al}_2\text{O}_3$ ). Other gangue minerals like  $\text{CuO}$ ,  $\text{ZrO}_2$  &  $\text{PbO}$  are found to be appreciable in PPM concentration from this residual bauxite developed from charnockite source. It is characterized by very high  $\text{Fe}_2\text{O}_3$  constitute of 83% by weight, low  $\text{Al}_2\text{O}_3$  constitute 14 % conveys it as a low grade bauxite (laterite) & 0.36 % of  $\text{TiO}_2$  portrays it as Iron rich laterite at Selurnadu (Table.1, Fig.7). It is also characterized by medium  $\text{Al}_2\text{O}_3$  of 39.67 weight %, medium high  $\text{Fe}_2\text{O}_3$  concentration of 55.32 % & 1.61 % of  $\text{TiO}_2$  by weight conveys it as a medium grade bauxite at Thinnanur. Low  $\text{Al}_2\text{O}_3$  weight % of 25.73, high  $\text{Fe}_2\text{O}_3$  concentration of 71.58 % & 0.23 % of  $\text{TiO}_2$  by weight conveys it as medium low grade bauxite (aluminous laterite) at Ariyurnadu.

Above geochemical data reveals about respective site specific  $\text{Al}_2\text{O}_3$  percentage of Bauxite within study area kolli malai (Table.1, Fig.7).

Table 1: XRF Data for Kollimalai Bauxite Samples

Oxides	Selurnadu	Ariyurnadu	Tinnanur	Concen.
$\text{Al}_2\text{O}_3$	14.023	39.66	25.727	%
$\text{SiO}_2$	1.178	1.54	1.075	%
$\text{P}_2\text{O}_5$	0.624	0.87	0.795	%
$\text{CaO}$	0.114	0.128	0.106	%
$\text{Sc}_2\text{O}_3$	26.4	0	0	ppm
$\text{TiO}_2$	0.356	1.606	0.227	%
$\text{V}_2\text{O}_5$	257.4	0.146	423.6	ppm
$\text{Cr}_2\text{O}_3$	692.6	0.359	673.6	ppm
$\text{Fe}_2\text{O}_3$	83.165	55.32	71.58	%

NiO	287.4	0	271.5	ppm
CuO	211.1	139.6	245.1	ppm
ZnO	95.3	0	80.7	ppm
Ga <sub>2</sub> O <sub>3</sub>	62	115.8	0	ppm
As <sub>2</sub> O <sub>3</sub>	0	0	0	ppm
Rb <sub>2</sub> O	0.121	91.8	0.1	%
ZrO <sub>2</sub>	284.2	541.7	46.5	ppm
CdO	0.17	0.153	0.156	%
BaO	280.4	557	0	ppm
La <sub>2</sub> O <sub>3</sub>	0	0	86.7	ppm
IrO <sub>2</sub>	0	0	101.6	ppm
PbO	269.5	166.2	119.5	ppm
Re	17.5	0	46.7	ppm

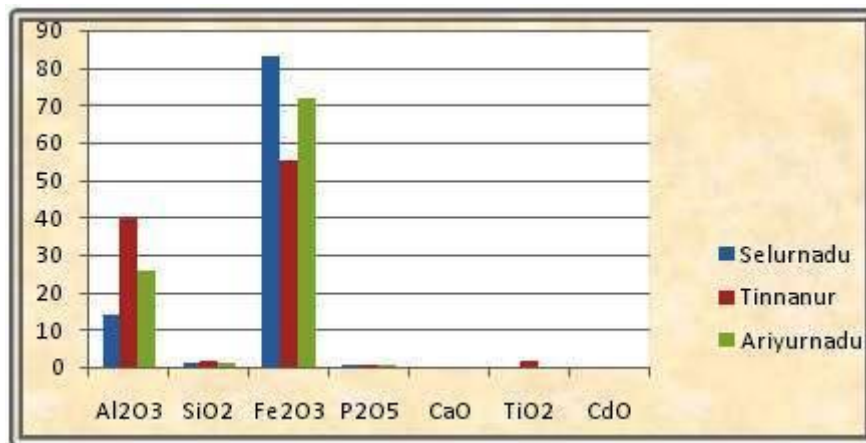


Fig 7: Bar Diagram of Al<sub>2</sub>O<sub>3</sub> - Fe<sub>2</sub>O<sub>3</sub> Concentration

## 8. 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 lecture, 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 lecture without any structure can be identified as pisolitic Cliachite. It is characterized by very high Fe<sub>2</sub>O<sub>3</sub> constitute of 83% by weight, low Al<sub>2</sub>O<sub>3</sub> of 14 % & 0.36 % of TiO<sub>2</sub> portrays it as Iron rich laterite at Selurnadu (Table.1, Fig.7). It is also characterized by medium Al<sub>2</sub>O<sub>3</sub> of 39.67 weight %, medium high Fe<sub>2</sub>O<sub>3</sub> concentration of 55.32 % & 1.61 % of TiO<sub>2</sub> by weight conveys it as a medium grade bauxite at Thinanur. Low Al<sub>2</sub>O<sub>3</sub> weight % of 25.73, high Fe<sub>2</sub>O<sub>3</sub> concentration of 71.58 % & 0.23 % of TiO<sub>2</sub> by weight indicates it as medium low grade bauxite (aluminous laterite) at Ariyurnadu. Above geochemistry reveals about the site specific ore percentage of Bauxite within study area kolli malai.

## ACKNOWLEDGEMENTS

Authors are indebted to DST, Govt. of India for funding Network Project BDA – HSRS under NISA programme for above project with file No: BDID/1/23/2014-HSRS 18.03.2016 to carry the above work which forms the part of the project and thankful to Dr. M. Sundararajan Scientist, National Institute for Interdisciplinary Science and Technology (CSIR)-Tiruvananthapuram for caring out Analytical work.

### REFERENCES

- [1] Ali Asghar Nazari., (1999) Geochemical studies of lateritic – Bauxite of Talgod – Mundalli area, North kanara, karnataka state. Ph.D thesis, University of Mumbai.
- [2] Bardossy, Gyorgy, \_1979, Growing significance of bauxites: Episodes, 1979, no. 2, p. 22-25.
- [3] Bracewell, Smith, 1962, Bauxite, alumina and aluminium: [London], Great Britain Overseas Geological Surveys, Mineral Resources Division, 235 p.
- [4] Bushinskiy, G. I., .1975, Geologiya boksitov [Geology of bauxite] (2d ed.): Moscow, Izdatel'stvo Nedra, 416 p.
- [5] Hosking, J. R., and Tubey, L. W., 1973, Experimental production of calcined bauxites for use as road aggregate: Great Britain Transport and Road Research Laboratory Report L R 588, 15 p.
- [6] Industrial Minerals, 1974, Bauxite and alumina offer more than aluminium: Industrial Minerals, no. 85, p. 9-23.
- [7] Krishnaswamy, S., (1958). Bauxite occurrences in the Shevaroy Hills, Salem District, Madras. Unpub. G.S.I. P.R. for the F.S. 1956-57.
- [8] Kumar, G. S., and others, 1977, Monograph on bauxite: Indian Bureau of Mines Mineral Facts and Problems, no. 5, 465 p.: Supplement, 8 p.
- [9] Mani, G., (1977). Report on the investigation for bauxite in Kollimalai, Salem District, Tamil Nadu, GSI Unpub. P.R. for the F.S. 1975-76.
- [10] Ramadurai S., (1968) Systematic geological mapping in parts of Namakkal and Rasipuram taluks, Salem district, Madras State. Geol. Surv, India (unpublished report).
- [11] Rao, P. S., (1979) Inter relationship of Bauxite and Laterites in kanhangad – kumbla area, kannanore Dist., kerala, south India, Lateritisation process, pp. 232 – 236.
- [12] Roy Choudhury, M. K., (1955) Bauxites of Indian and their utilization, Ind. Min., vol.9, pp. 195-222.
- [13] Schellmann, Werner, 1975, Formation of and prospecting for tropical bauxite above silicate rocks: Mining Magazine, v. 133, no. 1, p. 33-39.
- [14] Suman Babu, P., T.J. Majumdar & Amit K. Bhattacharya (2015) Study of spectral signatures for exploration of Bauxite ore deposits in Panchpatmali, India, Geocarto International, 30:5, 545-559,
- [15] Zans, V. A., 1961, Classification and genetic types of bauxite deposits: Inter - Guiana Geological Conference, 5th, Georgetown, British Guiana, 1959, Proceedings, p. 205-211.