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Bauxite Mineral Exploration Study of Mainpat Plateau Deposits in Surguja District, Chhattisgarh, India

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***Abstract*—Mainpat is located In Survey of IndiaTopographicsheet No. 64 N/5 forms an almost oval, E - W elongated plateau with an average altitude of 1053 m occupying about 470 km^2 area, which is situated in the southeastern**

Part of the Surguja district. Bauxite is widely developed in the form of pockets and lenses within Extensively developed laterite over the Deccan basaltic plateau. Mainpat area was characterized By having aluminous rock with whitish pink Gibbsite, brownish laterite were Identified in megascopic studies, Microscopic studies shown presence of gibbsite, Diaspore, Goethtie and Cliachite while XRD studies shown the whole rock Samples include presence of Gibbsite [Al(OH)$_3$]2,Anatase(TI0$_2$), Diaspore

[Al OH)$_2$, Hematite (Fe0$_3$) and Boehmite. Mainpat Bauxite is present as cap rock with brownish laterite at the top followed by bauxite then lithomorphs and weathered basalt at the bottom. The presence of boehmite was an evidence of intense weathering of kaolin to form bauxite deposit; this was conformed after doing full petrography test with transmission Electron Microscopy.

The cause of intense chemical weathering may result from reaction with groundwater and precipitation. High temperature, rainfall, and regional groundwater system in this region have induced an intense weathering on the deposit. Fe and Mn are immobile and insoluble except in soluble complexes at low pH gibbsite in abundance among Aluminum ore. This mineral is only formed in the unsaturated toxic zones, where post depositional weathering is most intense. The values of iron oxide in the bauxite samples of the study area range from

12.91 to 46.16%. Fe in the samples from the study area is insoluble and immobile and this support post depositional alteration in the area. Bauxite is a principal ore of aluminium which is one of the important nonferrous metals used in the modern industry. Hydrated aluminum oxides present in the bauxite ore are diaspore and boehmite, $Al_2O_3.H_2O$ (Al_2O_3 - 85%; Al - 45%); gibbsite or hydrargillite, $Al_2O_3.3H_2O$ (Al_2O_3 - 65.4%; Al - 34.6%) and bauxite (containing colloidal alumina hydrogel), $Al_2O_3.2H_2O$ (Al_2O_3 - 73.9%; Al - 39.1%).

Keywords— ***Bauxite,Mineral exploration, Mainpat Surguja District.***

I. INTRODUCTION

Bauxite is basically an aluminous rock containing hydrated aluminum oxide as the main constituent and iron oxide, silica and titania in varying proportions.Bauxite is a principal ore of aluminium which is one of the most important nonferrous-metals used in the modern industry. The name “bauxite” was proposed by Dufrenoy in 1845[1] for a material occurring near Les Beaux, France, that has been found to consist mainly of a mixture of hydrated aluminum and red iron oxides. Hydrated aluminum oxides present in the bauxite ore are diaspore and boehmite, $Al_2O_3.H_2O$ (Al_2O_3-85%; Al- 45%); gibbsite or hydrargillite, $Al_2O_3.3H_2O$ (Al_2O_3- 65.4%; Al-34.6%) and bauxite (containing colloidal alumina hydrogel), $Al_2O_3.2H_2O$ (Al_2O_3-73.9%; Al-39.1%). The iron oxide in bauxite ore is present as haematite or goethite, silica as clay and free quartz and Titania as leucoxene or rutile.Bauxite is an amorphous or clay likes substances. The usual colour of Bauxite is pink but with tin impurities it becomes brownish. It shows oolitic and pisolitic structures.

Its hardness is variable but has a low specific gravity of about 2.6 and the composition is Al_2O_3. Aluminum finds its largest use in the alloys of which Duralumin is an alloy of aluminum

with Copper, Magnesium and Manganese. Aluminum alloy is chiefly employed in the construction of Air craft bodies, petrol tank, cylinder heads etc. They ate also used for window frames and several interior fittings. The other major uses of bauxite are in refractories, abrasives, chemicals and aluminous cements. Refractory bauxite is used mainly in making firebrick and mixes having Al_2O_3 contents in the range of 70-90 percent [2]. Abrasive bauxite is used for fused alumina grinding and polishing materials.

The total reserves of bauxite in India are estimated at 27.40 crores tones. The major bauxite producing states in India are Odisha, Jharkhand, Gujarat, Maharashtra, Madhya Pradesh, Karnataka, Tamil Nadu, Uttar Pradesh and Goa in a descending order of importance.

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•***Odisha:*** Odisha is the largest producer of bauxite in the country and contributes about one-third of the total production. Kalahandi, Bolangir, Koraput, Sundargarh and Sambalpur are the main bauxite producing districts.
Kachchh and Surat are the main bauxite-producing districts.

II. STUDY AREA

A. General overview

The area of study Mainpat Plateau falls in Surguja district in Chhattisgarh state, India. It is located in the Survey of India toposheet numbers 64 N/5 lying between longitudes E 83°18'0" to 83°22'30" and latitudes N 22°43'30" to 22°49'30". The Mainpat plateau covers an area of 83.33 Sq.km. The study area is occupied by Mainpat plateau which is covered by Deccan Traps. The average height of the plateau is 1053 m and maximum height is 1060 m above MSL at Barima and Mainpat village in the western side of the plateau. The top of the whole plateau is covered by laterite and bauxite. Laterite and bauxite is the residual product of extreme chemical weathering of preexisting aluminous rocks under favorable geomorphic, climatic and hydrogeological conditions.

The area has gone through intensive shearing and faulting. The Central India Shear Zone trending almost E-W passes through the central part of the plateau [3]. worked on exploration of bauxite of Barima and Khandraja blocks Mainpat Plateau. These deposits are found in an about 25 places (small and large deposits) in the area [4]. The mining of bauxite in these areas has been continuous since 1998 BALCO. The reserve of commercial bauxite in the Mainpat Plateau is about 33 metric tons [5].

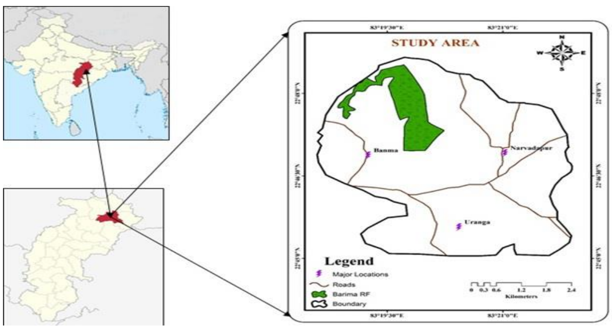

Fig.2.1. Base Map of the study Area

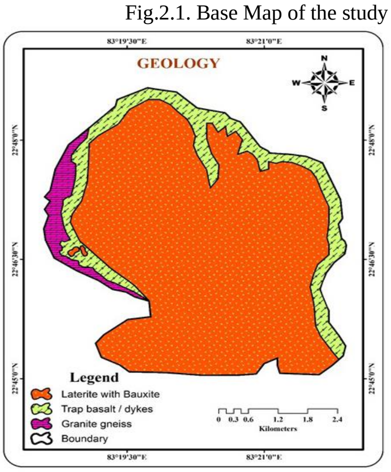

Fig.2.2. Geology Map of the study Area

The area of study Mainpat Plateau falls in Surguja district in Chhattisgarh state, India. It is located in the Survey of India toposheet numbers 64 N/5 lying between longitudes E 83°18'0" to 83°22'30" and latitudes N 22°43'30" to 22°49'30". The Mainpat plateau covers an area of 83.33 Sq.km. The study area is occupied by Mainpat plateau which is covered by Deccan Traps.

The Mainpat Plateau is a mesa landform exhibiting an even flat-topped topography. The northern part of the area is Kam-leshwarpur (1165 m) and western part of the area is Parpatia (1158m). The average height of the plateau is 1080 m Mean Sea Level (MSL).

As per Koppen's climate classification the Surguja falls in AW (AW denotes Tropical Swanah region) class which is based on temperature and vegetation. However, on the basis of vegetation type, the climate of the area is deciduous to Semi-arid. During summer temperature ranges from 150C to 450C while in winter season temperature fall down to 90C and rainy season starts from middle of June and ends by middle of September. Average rainfall during the year ranges from 150cm to 200 cm.

The area is drained by a series of stream lets which are part of Mand and Barnai drainage systems which ultimately forms the Hasdo and Rihand rivers system. The plateau has dendritic drainage pattern of its streams because of the undulating flat nature of plateau top and sometimes showing radial drainage pattern from its slopes. It is controlled by the fractures, lineaments, faults, topography and Lithology. Streams cut deep valley at the slope of the plateau.

The Mainpat plateau has a wide range of rock types varying in age from Archaeans (granite − gneisses, phyllite, etc.), Gondwanas and Deccan basalt. Archaeans were found at the foot hill overlain by Gondwanas at western escarpment and covered by basalt at the top. Bauxite and the associated kaolin deposits in the plateau region is hosted within igneous (basalt) rocks of upper Cretaceous to lower Paleocene age.

III . METHODOLOGY

A. Petrography and geochemistry

Three samples were collected from various exposed out crops of bauxite during field work in Mainpat plateau, Precautions has been taken to avoid weathered samples. The field relationship of ore minerals and rocks were illustrated in the sample location, field photographs give the field observation of the studyarea. Mineral identification studies using petrography &ore mineralogy were discussed below

B. Megascopic study of bauxite

Megascopic study shows that whitish pink colour with earthy rock is composed of gibbsite, brownish laterite as cap with weathered litho-morph at the bottom in (field photograph). Ore shows translucent aluminous laterite in Mainpat village. In same outcrop, Bauxite shows light colour aluminous laterite and dark colour laterites showsaluminous ore gibbsite which occur as enclosure, with in laterite as a brown cap. Laterites occurring at the top of the plateau has undergone alteration as whit-ish pink aluminous Bauxite

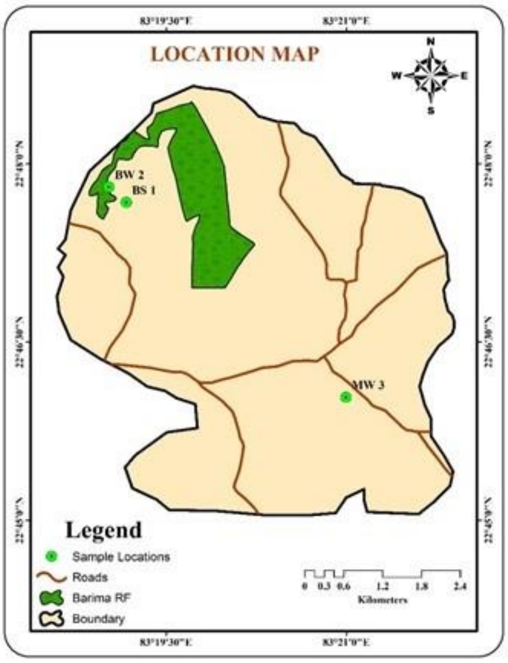

Fig.3.1. Sample location

Fig.3.2. Laterite profile of the study Area

Fig.3.3. Shows yellow colour aluminous laterite at the top, White Gibbsite (Bauxite) and dark colour cliachite at the bottom in the Mainpat village of Surguja District

C. *Petrography study of Bauxite*

Fresh samples were selected for preparation of micro sections for mineral identification studies. Under thin section, these minerals are identified as Gibbsite, Diaspore, Cliachite, Goethite and Feld-spar mineral assemblages.

1.Reflecting Microphotograph shows the brownish yellowish co-lour, 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 lustre, massive in nature, with no structure as pisoliticclia-chite.

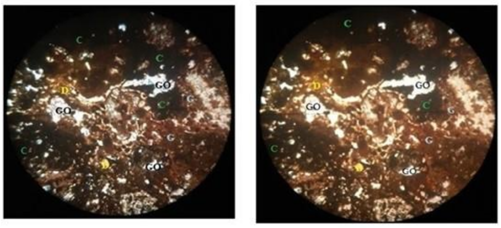

Fig.3.4. D-Diaspore, Yellow colour ,Oolitic strcture, weak pleachroism
GO- Geothite whitish blue,opaque, cleavage on (100) Plane
C- Cliachite, Deep brown opaque, Absence of Xlline structure
G- Gibbsite, pale brown weak pleochroism Moderate relief

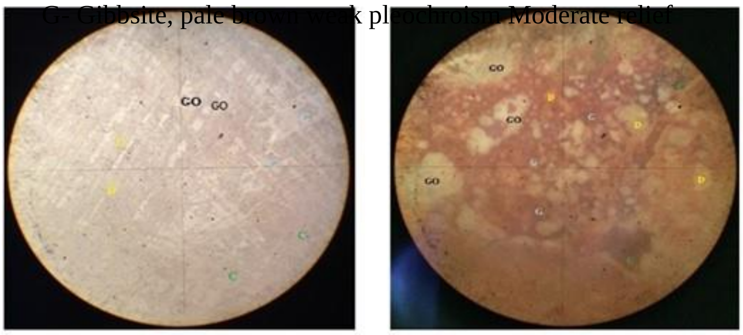

Fig.3.5. D-Diaspore, Yellow colour ,Oolitic strcture, weak pleachroism
GO- Geothite whitish blue,opaque, cleavage on (100) Plane
C- Cliachite, Deep brown opaque, massive, not structure
G- Gibbsite, pale brown weak pleochroism Moderate relief

D. *X- Ray Diffraction Studies (XRD)*

In many geological investigations, XRD complements other mineralogical methods, including optical light microscopy, Electron Probe Micro-Analysis (EPMA), and Scanning Electron Microscopy (SEM). X-ray diffraction is a versatile, non-destructive analytical technique for identification and semi-quantitative estimation of the various crystalline com-pounds, known as ‘phases’, present in solid materials and powders.

It provides a fast and reliable tool for routine mineral identification. It is particularly useful for clays, ultrafine grained minerals and mixtures or intergrowths of minerals, which may not lend themselves to analysis by other

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techniques. Laterite/Bauxite, composed of minerals may be studied by various analytical techniques. One such technique,

X-ray powder diffraction (XRD), is an instrumental technique that is used to identify minerals as well as other crystalline materials. Some mineralogical samples analyzed by XRD are too fine grained to be identified by petrological microscope. XRD analysis for mineral identification of bauxite/laterite samples was carried out in Laboratory of NIIST, CSIR, Thiruvanatha-puram with the help of X-ray Diffractometer (XPERT- PRO). Identification is achieved by comparing the X-ray diffraction pattern - or 'diffractogram' - obtained from an unknown sample with an internationally recognized database containing reference patterns for more than 70,000 phases. However, due to unavailability of mineral separation unit bulk XRD analysis was carried out.

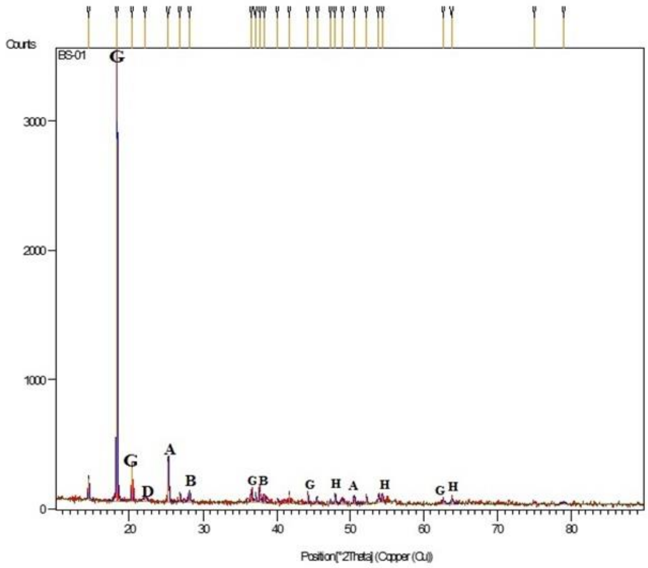

Fig.3.6. X-ray powder Diffraction pattern G-Gibbsite, B-Boehmite, D-Diaspore, H-Hematite, A-Anatase

IV. RESULTS AND DISCUSSION

A. *Results*

Whitish pink gibbsite, brownish laterite was identified in megascopic studies. Microscopic studies show presence of gibbsite, diaspore, goethite and cliachite.

XRD studies shows the whole rock samples include presence of gibbsite [Al $(OH)_3$], anatase (TiO_2), diaspore [AlO(OH)], hematite (Fe_2O_3), and boehmite (γ-AlO(OH)). All the samples analyzed from Mainpat area have diaspore, anatase, and gibbsite.

Gibbsite is present in abundance for all the three samples from the study area.

B. *Discussion*

Mainpat Bauxite is present as cap rock with brownish laterite at the top followed by bauxite then lithomorphs and weathered basalt at the bottom. The bauxite deposits of Mainpat Plateau are different in mineralogy and chemistry from the other deposits in the region. Minerals present in the Mainpat bauxite deposits are diaspore, gibbsite, anatase, hematite, and boehmite. The absence of quartz and micas in this deposit is an evidence of complete alteration of the clay phases (micas and feldspars) into bauxite. Several lines of data are discussed supporting weathering origin for bauxite in the plateau.

Gibbsite will breakdown under suitable acidic conditions to boehmite, which reacts with depolymerized silica solution to form kaolin [6]. The reverse is the situation in sample which contains some traces of boehmite and a higher alumina value compared to kaolinite. Silica is gradually removed from the kaolin in this area, leaving behind traces of boehmite. The presence of boehmite in this sample is an evidence of intense weathering of kaolin to form bauxite deposit. This idea is readily feasible by the use of Transmission Electron Microscopy (TEM) data.

The cause of intense chemical weathering may result from reaction with groundwater and precipitation. High temperature, rainfall, and regional groundwater system in this region have induced an intense weathering on the deposit. Fe and Mn are immobile and insoluble except in soluble complexes at low pH. The rate of weathering was relatively high in the unsaturated zone. The mineralogy of the bauxite deposits in the area shows the presence of gibbsite in abundance among Aluminium ore. This mineral is only formed in the unsaturated toxic zones, where post depositional weathering is most intense. The values of iron oxide in the bauxite samples of the study area range from 12.91 to 46.16%. Fe in the samples from the study area is insoluble and immobile and this support post depositional alteration in the area.

There is a straight relation between bulk chemistry of bauxite ore and mineral mass abundance of the selected three samples. In Barima South Al2O3 weight percentage is 58% whereas XRD data give mass percentage of Gibbsite as 70% to confirm it as high grade Bauxite. In Barima west XRF gives weight percentage of Al2O3 as 38% proportionally there is a drop in mass percentage of gibbsite as gibbsite to confirm it as aluminous laterite. Thus XRF and XRD data are rather supplement to each other by conveying respective bulk chemistry of aluminous ore and mass abundance of individual mineral mass percentage to agree the mineral abundance was due to respective weight percentage of ore.

V. CONCLUSION

Bauxite is a principal ore of aluminium which is one of the important nonferrous metals used in the modern industry

Hydrated aluminium oxides present in the bauxite ore are diaspore and boehmite, $Al_2O_3.H_2O$ (Al_2O_3 - 85%; Al - 45%); gibbsite or hydrargillite, $Al_2O_3.3H_2O$ (Al_2O_3 - 65.4%; Al -

34.6%) and bauxite (containing colloidal alumina hydrogel),

bauxite ore is present as haematite or goethite, silica as clay and free quartz and Titania as Anatase. Bauxite is an amorphous or clay likes substances. The colour of Bauxite is pink but with tin impurities it becomes brownish. It shows oolitic and pisolitic structures. Its hardness is variable but has a low specific gravity of about 2.6 and the composition is Al_2O_3.

VI. ACKNOWLEDGMENT

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