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Petrological Characteristics of Lateritic Bauxite Deposits of India and Their Significance in Mineral Processing

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Abstract

India is endowed with 3896 million tons of bauxite resources and ranking it fifth globally. Thebauxite comprises various minerals such as gibbsite, boehmite, diaspore, hematite, goethite, kaolinite, quartz, anatase and rutile. India possesses abundant lateritic bauxite resources originating from parent rocks like Khondalite, Deccan trap basalt, Granite Gneiss, Sandstone, etc., each exhibiting its specific characteristics. The geotechnological evaluation of India's lateritic bauxite deposits, conducted by Jawaharlal Nehru Aluminium Research Development and Design Centre (JNARDDC), revealed the presence of two types of deposits: high-level and low-level (coastal). In this study, bauxite and laterite samples were collected from different regions in India and subjected to comprehensive technological evaluation.

Mineral processing techniques are optimized based on the mineralogical and petrological characteristics of the bauxite deposits. The mineral liberation, association, and alteration information obtained through petrological analysis guide the selection and optimization of various methods. The understanding of the mineralogy and petrological characteristics also assists in predicting the behaviour of bauxite during the processing stages, facilitating process control and minimizing losses.This paper aims to highlight the petrological, chemico-mineralogical characteristics of Indian lateritic bauxite deposits and emphasize the significance of petrology and mineralogy in their evaluation and mineral processing.

Microscopic examination plays a vital role in mineral characterization and the beneficiation process by enabling mineral identification, texture analysis, grain size, mineral liberation, association, alteration, and process optimization. Such comprehensive analysis contributes to maximizing the economic value of mineral resources, aiding informed decision-making in exploration, mining, and mineral processing industries.

Keywords: Bauxite, Lateritic Deposits, Petrological Characteristics, Mineralogy, Mineral Processing

Introduction

Lateritisation can be described as a process where mineral phases undergo re-equilibrium to adapt to the temperature, pressure and other environmental conditions present at the Earth's surface, particularly within the underlying weathering zone, which can vary in thickness (Bardossy and Aleva, 1990). Laterites are formed through intense subaerial weathering of alumino-silicate rocks under warm and humid climatic conditions, primarily in the intertropical regions of the world (Sarkar *et al.,* 2023; Adinda *et al.*, 2021, Bhukte, *et al.*, 2020). Bauxite ore results from the weathering of parent rocks, such as Khondalite, Deccan Trap basalt, Granite gneiss, Charnockite, and others. Based on the bedrock lithology, bauxite deposits are mainly classified into three types: (a) lateritic bauxite, (b) karst bauxite, and (c) Tikhvin type. Lateritic bauxite overlays aluminosilicate rocks of igneous, sedimentary and metamorphic origins. Karst bauxites occur in depressions on karst or eroded surfaces of carbonate rocks, and this type is predominant in Europe, the Caribbean region, the western Pacific region, and China. Tikhvin types are detrital bauxite deposits that overlay eroded surfaces of aluminosilicate rocks and are the result of the erosion of lateritic bauxite deposits (Bhukte *et al.*, 2023; Singh and Srivastava, 2018).

India has significant bauxite resources found in the Eastern Ghats region, although laterite and bauxite occurrences are distributed throughout various parts of the country (Adhikari, 2021; IBM, 2022). Lateritic bauxite deposits are located in the states of Odisha, Andhra Pradesh, Chhattisgarh, Madhya Pradesh, Maharashtra, Jharkhand, Gujarat, Goa, Karnataka, Kerala, Tamil Nadu, Uttar Pradesh, Rajasthan, and the union territory of Jammu (IBM, 2022; USGS, 2022; Bhukte *et al.*, 2020). There are distinct geological variations in the mode of occurrence and configuration of ore bodies in different deposits. Based on studies of Indian bauxites, three broad groups can be identified: (1) thick continuous ore bodies with undulating roofs and floors, which are mostly found in the Eastern Ghat region; (2) continuous ore bodies with variable thickness and grade, found in selected Western Ghats and Gujarat bauxite deposits; and (3) pocket and discontinuous ore bodies, prevalent in most central Indian and Gujarat deposits (Bhukte *et al.*, 2018; Bhukte Chaddha, 2014; Kale and Wadpalliwar, 2016). The

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