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Geology and geochemistry of the Xiaoshanba bauxite deposit, Central Guizhou Province, SW China: Implications for the behavior of trace and rare earth elements

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ABSTRACT

In China, bauxite is mainly of the karst type. Karst bauxite deposits in Central Guizhou are widely distributed in the Qingzhen, Xiuwen, and Zunyi districts. The Xiaoshanba deposit is located in the Xiuwen district and is hosted in the Lower Carboniferous Jiujialu Formation. It shows parallel unconformity with the overlying and underlying strata. The main chemical contents of the bauxite ore in the Xiuwen district is Al₂O₃ (55.7 to 73.5 wt. %), followed by SiO₂, Fe₂O₃, TiO₂, CaO, MgO, S, P, etc. There are obvious enrichments in rare earth elements (REEs) and immobile trace elements (such as Ti, Nb, Zr, Hf, Ta, and Th) in the Al-bearing rocks.

The mass change calculation (MC) is an effective means of investigating the relative mobility of elements. Here we present the multiples of mass change calculation (MMC), which represents an improvement over the MC, and is effective for element mobile investigations. The MMC results for REEs of the Xiaoshanba Al-bearing rocks showed grouping phenomenon, in which REEs were divided into four groups (Group A: La–Ce–Pr–Nd; Group B: Pm–Sm–Eu–Gd; Group C: Gd–Tb–Dy–Ho, and Group D: Er–Tm–Yb–Lu) and showed different fractionation trends in the MMC curves. The tetrad characteristic of the REEs (tetrad effects) most likely induced the special grouping phenomenon. During bauxite mineralization, REE fractionations caused by mineral control, especially the widespread distribution of accessory minerals that are rich in REEs such as Ti-dioxide minerals (i.e., TiO₂ such as rutile and anatase) and zircon, and water–rock interactions resulted in the REE grouping phenomenon in the Xiaoshanba profile.

The majority of these immobile elements tend to concentrate in the accessory minerals of bauxite, and barely any elements (except Li and Ga) seem associated with the ore-forming minerals. For instance, Ti-dioxide minerals played an important role in the accumulation of some elements, such as Ti, V, Nb, and Ta, etc. Another important mineral was zircon, which is rich in Zr, Hf, and Th, etc. In general, there were two main factors that influence the content of immobile elements in the karst bauxite profile: (a) the chemical composition of the precursor rock (the higher the content of immobile elements in the parent rock, the higher the content of accessory minerals and immobile elements in bauxite), and (b) the weathering degree of the precursor rock (the stronger the degree of weathering, the higher the content of accessory minerals and immobile elements in bauxite).

Keywords: Karst bauxite; Central Guizhou Province; Mass change calculation; immobile element

1. Introduction

Bauxite is the primary raw material used to produce aluminum and it is abundant in nature. Bauxite deposits can be classified into three categories according to their occurrence status and genesis, i.e., lateritic, karst, and Tikhvin-type bauxite. Karst and lateritic are bauxite deposits that overlie carbonate and aluminosilicate rocks,

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