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Formation mechanism of boehmite and diaspore in karstic bauxites: Trace element geochemistry in source materials using a large sample geochemical dataset and a random forest model

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Abstract

Boehmite and diaspore are the two economic ore minerals of karstic bauxites. Although their genesis has been studied from different perspectives, their formation mechanism is controversial. The random forest (RF) model of machine learning was employed to extract the combined characteristics of trace elements in boehmite-type bauxite (BTB) and diaspore-type bauxite (DTB). The BTB predominantly exhibits higher median concentrations of Co, Ni, V, and Cr, while the DTB exhibits a more significant enrichment in elements of U, Hf, Th, and Zr. Combining the characteristics of La/Yb and Ga/Al ratios, it is found that disparities between BTB and DTB are mirroring those between basic rocks and intermediate-felsic rocks. Furthermore, the Zr-Cr-Ga diagram and Ni/Zr vs. Cr/Zr plot were utilized to examine the correlation between karstic bauxite (BTB or DTB), lateritic bauxite, and their respective weathered parent rocks. It is found that BTB exhibits consistent characteristics with lateritic bauxite weathered from basic rock and its parent rocks. Similarly, DTB exhibits consistent characteristics with lateritic bauxite weathered from intermediate-to-felsic rocks and their parent rocks. Through studying the relationship between Ni content and Fe^{3+}/Fe^{2+} ratios, it has been discovered that the presence of trace elements like Ni in source materials can affect or regulate the ore-forming process, ultimately driving the transformation of gibbsite into either boehmite or diaspore. Consequently, the formation of BTB and DTB is significantly influenced, or even governed, by the composition of their source materials. Our study highlights a novel insight into the significant impact of the source material's geochemical composition on the formation of boehmite and diaspore.

Keywords: Boehmite, diaspore, formation mechanism, trace element geochemistry, random forest model