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Synthesis of boehmite-type GaOOH: A new polymorph of Ga oxyhydroxide and geochemical implications

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Abstract

Gallium (Ga) and aluminum (Al) belong to group IIIA elements in the periodic table. They show a coupled geochemical behavior in most natural systems and are considered as “geochemical partners.” However, compared with the principal oxyhydroxides of Al in nature, gibbsite [$Al(OH)_3$], boehmite (γ-AlOOH), and diaspore (α-AlOOH), only the analogs söhngeite [$Ga(OH)_3$] and tsumgallite (α-GaOOH) were reported. In this work, boehmite-type GaOOH (γ-GaOOH), a new polymorph of GaOOH, was synthesized for the first time using boehmite (γ-AlOOH) as a template. The synthesized γ-GaOOH was characterized by a series of techniques, including X-ray diffraction (XRD), high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM), and selected area electron diffraction (SAED). Furthermore, a model based on the boehmite structure was successfully applied to define the γ-GaOOH structure by the Rietveld method. Results from sample characterization and structural refinement support the successful synthesis of boehmite-type GaOOH, and thus it is referred to as γ-GaOOH. The synthesis of γ-GaOOH in the laboratory is valuable to understanding the Ga geochemistry and its enrichment process in Ga-rich boehmite in coal and bauxite.

Keywords: Gallium, boehmite analog, γ-GaOOH, template synthesis, Ga geochemistry