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Late Carboniferous karst bauxite deposits in North China Craton: Deposit characteristics and Critical metal elements enrichment mechanism

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Bauxite, a chemical residuum after intense subaerial weathering, comprises aluminum oxides and/or hydroxides with smaller quantities of Fe-oxyhydroxides and clay minerals. The North China Craton hosts one of the largest karst bauxite deposits globally, formed over a remarkable 150-million-year-long interval between the Ordovician and Late Carboniferous. We propose a petrological nomenclature and classification scheme for bauxitic rocks based on three units (aluminum hydroxides, iron minerals and clay minerals) according to mineralogical composition. The bauxite series in the North China Craton, which can be divided into five sections, i.e., ferrilite (Shanxi-style iron ore, section A), bauxitic mudstone (section B), bauxite (section C), bauxite mudstone (debris-containing, section D) and dark mudstone-coal section (section E). Ferrilite has a total Fe_2O_3 content > 50% (main minerals: hematite and goethite); bauxite has Al_2O_3 > 35% and clay content < 50% (main minerals: diaspore and boehmite); and bauxite mudstone has Al_2O_3 > 35% and clay content > 50% (main minerals: clay minerals, with lesser amounts of diaspore). The mean contents of Li (892 ppm), B (327 ppm), ΣREE (584 ppm), Nb (43.1 ppm), Ga (41.3 ppm) and TiO_2 (1.36%) are relatively high, indicating industrial mining potential. Li is mainly in lithium-bearing chlorite (cookeite) and enriched in bauxite mudstone, whereas B and REE are present mainly as adsorbed ions on the surfaces of diaspore, boehmite and clay minerals, although LREE also might exist as independent mineral phases (< 3 μm diam.). Ti is mainly in rutile (rutile titanite) and enriched in bauxite mudstone, whereas Nb is enriched in the columbite phase of the bauxite mudstone. Ga mainly incorporated into the aluminous minerals by replacing Al in the form of isomorphic substitution, which is mainly contained in bauxite. Processes of mineral evolution linked to weathering played an important role in the enrichment of these elements. This pattern of critical metal enrichment reflects a three-stage genesis of bauxite linked to in situ weathering and bauxitization, which provide insights into the weathering history of other bauxite deposits globally.