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Distribution and speciation of chromium in active and legacy nickel laterite tailings

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Global transition to cleaner energy sources has raised the demand for metals, exponentially increasing the amount of wastes generated from their extraction [1]. For example, the extraction of nickel, an important energy transition metal, from very large-tonnage, low-grade laterite ore deposits lead to millions of tonnes of tailings containing toxic heavy metals (e.g., chromium). However, nickel laterite tailings are vulnerable to leaching, or erosion [2], increasing the potential mobility of chromium in the environment, and its potential impacts on human health. Therefore, it is crucial to determine the fate and toxicity of chromium in nickel laterite tailings.

In this study, we used a suite of mineralogical and geochemical techniques (e.g., XRD, TEM, XAS etc.) to visualize and quantify the distribution and speciation of chromium in active and rehabilitated nickel laterite tailings. The tailings are mainly comprised of iron (oxyhydr)oxides and sulfates, containing chromium concentrations up to 20,000 mg kg^{-1}. In contrast to nickel laterite ore bodies where chromium is hosted in various iron-bearing minerals [3], chromium is mainly associated with hematite in the tailings, predominantly present as the less harmful Cr(III) species. The formation and transformation of hematite controls the fate of the chromium in both active and legacy mine tailings. Our results highlight that, although nickel extraction releases chromium from laterite ores, it also creates ideal conditions for the formation of iron-bearing mineral phases such as hematite that successfully sequester chromium in its less toxic form.

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