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Is beudantite a stable host phase of arsenic and lead? New insights from molecular-scale kinetic analyses

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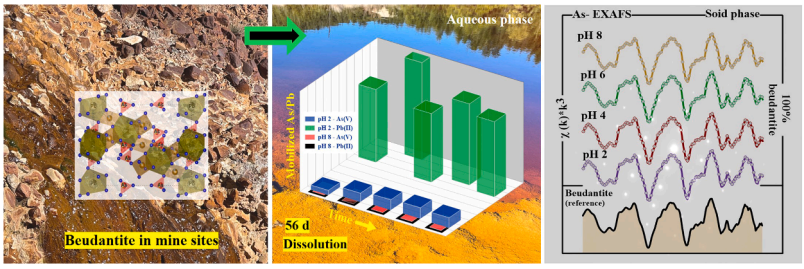
HIGHLIGHTS

- The stability and solubility of beudantite was examined across a broad pH spectrum.
- Acidic pH conditions resulted in slightly elevated in aqueous As and Pb content.
- Beudantite exhibited strong stability against dissolution in pH range of 4 to 8.
- No secondary mineralogical transformation of beudantite was observed.
- Beudantite can serve as a stable host mineral for As and Pb in contaminated regions.

GRAPHICAL ABSTRACT



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ABSTRACT

Beudantite, an As-Pb containing Fe(III) sulfate secondary mineral, is formed via the oxidation of sulfide-rich tailings in mining-impacted regions. The geochemical stability of beudantite plays a key role in controlling the cycling and transport of As and Pb in mine sites. However, the fate of beudantite under dynamic pH conditions and its effect on As and Pb mobility remain elusive. We investigated the mobility dynamics of As and Pb during the dissolution of beudantite under variable pH conditions (2–8) relevant to mine sites by using a complementary suite of analytical methods. Results demonstrate that under acidic pH conditions, aqueous As and Pb content increased slightly, with just 0.7 % and 6.7 % of As and Pb partitioned from the beudantite crystal structure over 56 days. Notably, the rate at which the dissolution of beudantite led to solubilization of elements followed the order Fe > As > Pb within the first 2 h of dissolution. In contrast, the order shifted to Pb > Fe > As after 2 h. Arsenic K-edge X-ray absorption spectroscopy analyses revealed no shifts in As speciation or secondary mineralogical transformation. Here, we show for the first time that beudantite could be considered a relatively stable mineral host for As and Pb over a broad spectrum of environmental conditions. Beudantite can be expected

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