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Identification and characterization of nanosized tripuhyite in soil near Sb mine tailings

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Abstract

In soil near tailings from an antimony (Sb) mine, we found micro-grains coated with an antimony-rich layer. These grains were characterized in detail using multiple advanced analytical techniques such as micro-X-ray absorption near edge structure (μ-XANES), micro-extended X-ray absorption fine structure (μ-EXAFS), micro-X-ray diffraction (μ-XRD), transmission electron microscope (TEM), and electron probe microanalysis (EPMA). The EPMA showed that one soil grain (grain A) locally accumulated a large amount of Sb in the secondary phases (40–61 wt% Sb_2O_5) with significant Fe (20–28 wt% Fe_2O_3). The spatial distribution of Sb in the grain was similar to that of iron. Both Fe μ-XANES and μ-XRD of the Sb hot spots in grain A consistently showed that the secondary products were dominantly composed of ferric antimonate, tripuhyite ($FeSbO_4$). Fits to the Sb *K*-edge μ-EXAFS of this phase showed second-neighbor coordination numbers ~30% smaller than in bulk tripuhyite, indicating that the tripuhyite included in grain A is nanoparticulate and/or has a high structural disorder. The TEM analysis suggests that the particle size of tripuhyite in grain A was around 10 nm, which is consistent with the size range indicated by μ-XRD and μ-EXAFS. This is the first report showing tripuhyite with nanocrystallinity in natural soil to date.

Keywords: Antimony, tripuhyite, micro-XAFS, micro-XRD, HRTEM