Stability of arsenic species in exposed and water-covered tailings at the Ketza River Mine site, Yukon

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Abstract

The Ketza River mine is a former gold mine in Yukon, Canada operated from 1988 to 1990 by producing over 2.8 tons of gold. There are approximately 310,000 tons of tailings impounded in a valley setting at the mine site. The tailings were sampled in 2006 at two locations with the aim to examine the extent of sulfide oxidation and determine the extent of mineralogical changes with depth for the exposed and water-covered tailings. The tailings contain on average 4 to 7 wt % As distributed largely among goethite (FeOOH), amorphous ferric arsenate ($FeAsO_4$•4-7H_2O), scorodite ($FeAsO_4$•2H_2O), arseniosiderite ($Ca_2Fe_3(AsO_4)_3O_2$•3H_2O), yukonite ($Ca_2Fe_3(AsO_4)_4(OH)$•12H_2O), an and an unknown hydrated Ca-Fe arsenate. Arsenopyrite (FeAsS) and pyrite (FeS_2) are minor with quantities of less than about 0.7 wt % in the exposed tailings and between 0.4 and 2.3 wt % in the water-covered tailings. Arsenopyrite and pyrite occur as relict particles often embedded in or rimmed by goethite, scorodite and Ca-Fe arsenates indicating that both are oxidized. Characterization of the tailings by bulk x-ray absorption spectroscopy (XAFS) indicated that As is essentially pentavalent which remained unchanged with depth. XAFS results also indicated that goethite and ferric arsenate are the most abundant As-bearing minerals in both the exposed and water-covered tailings. Scorodite appears to be enriched near the surface of the exposed tailings. Yukonite or arseniosiderite are relatively abundant in the exposed tailings whereas an amorphous Ca-Fe arsenate occurs in the water-covered tailings. Speciation of As in arsenopyrite and pyrite and their oxidation products examined by collecting micro-XAFS spectra from about 2x2 μm spots indicates that As originally occurring as As^{-1} in arsenopyrite and pyrite is transformed to As^{+5} in the reaction rims.