Trace Copper and Zinc Release From Jarosite

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Trace metal bioaccessibility in aquatic environments is partly controlled by interaction with secondary minerals, and may involve both sorption-desorption and coprecipitation-dissolution reactions. Many studies have focused on trace metal sorption-desorption, whereas relatively fewer studies have documented trace metal coprecipitation-dissolution, despite ample evidence for the prevalence of trace metal-bearing secondary minerals in the environment. This work documents Cu and Zn release during experimental dissolution of pure and trace metal-substituted jarosite—one of many secondary Fe phases known to host trace metals in mine waste.

We synthesized pure, Cu-substituted (1.7 wt.%), and Zn-substituted (1540 ppm) K-jarosites with minor hydronium substitution (10%, mol/mol), then conducted oxic batch leach experiments at 22 °C and pH near 3.6 in order to emulate acid mine drainage conditions. The rates of dissolution (log moles jarosite m^{-2} s^{-1}) were the following: -10.3 (jarosite), -9.96 (Cu-jarosite), and -9.95 (Zn-jarosite). These rates are comparable to similar experiments with synthesized K-jarosite (-9.3) [1] and natural K-Na-jarosite (-11.2) [2]. During 40 days of leaching, dissolved Cu and Zn concentrations increased linearly. Copper was particularly more mobile than Fe, with dissolved Cu:Fe increasing from 2.5 to 6. In all experiments, Fe concentrations were highest initially, then decreased to a steady-state after 6 days, suggesting early dissolution followed by precipitation. Because dissolved K and SO_4 did not show similar behavior, an Fe (oxyhydr)oxide precipitate was anticipated, but no other solid Fe phases were detected by SEM-EDS, bulk XRD, or Fe K-edge X-ray absorption spectroscopy. An Fe (oxyhydr)oxide phase could be present at below the detection limit of these techniques, however.

Given that these experiments were conducted under conditions where jarosite is typically stable, the release rates of dissolved Cu and Zn likely represent minima, whereas trace metal release rates in open natural systems could be higher. These results suggest that trace metals that are coprecipitated with secondary minerals may be more mobile, and therefore more bioaccessible, than expected.

[1] Elwood Madden *et al* (2012) Geochimica *et al Cosmochimica Acta*, **91**:306-321 [2] Welch *et al* (2008) *Chemical Geology*, **254**:73-86