Kinetics of Arsenopyrite Oxidative Dissolution by Oxygen

Forest P. Walker

Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

Masters of Sciences
In
Geosciences

Madeline Schreiber, Chair
J. Donald Rimstidt
Tom Burbey

April 16, 2004
Blacksburg, VA

Keywords: arsenic, oxidation, arsenopyrite

Kinetics of Arsenopyrite Oxidative Dissolution by Oxygen

Forest P. Walker

Abstract

The objective of this study is to use a mixed flow reactor system to determine the dissolution rate and infer potential mechanisms of arsenopyrite (FeAsS) oxidation by dissolved oxygen at 25°C and circumneutral pH. Release rates for iron, arsenic and sulfur are calculated for a variety of initial dissolved oxygen (DO) concentrations. Results indicate that the rate of arsenopyrite oxidation, represented by the rate law $r = A(6.76 \times 10^{-11})$ where the rate, r, is in mol/s and surface area, A, is in m^2, is not significantly dependent on DO concentration. Arsenic and sulfur are released in a 1:1 molar ratio while iron is released more slowly due to precipitation of iron oxyhydroxides. Our results suggest that the rate determining step in arsenopyrite oxidation is determined by the attachment of oxygen at the anodic site in the mineral, and not the transfer of electrons from the cathodic site to oxygen, as is suggested for other sulfide minerals such as pyrite.

Previous work on FeAsS oxidation has been limited to low pH conditions with ferric iron as the oxidant. However, not all arsenopyrite weathering occurs exclusively in acidic environments. For example, at an abandoned arsenopyrite mine in Virginia, the pH of ground and surface waters is consistently between 4 and 7. Results of this study provide important insight to arsenic mobilization processes and rates, at field-relevant conditions, consequently aiding in the effort to understand arsenic release and retention in the environment.