EXECUTIVE SUMMARY

Accurately accounting for sulfide mineral oxidation rates is of primary importance for understanding the short and long term reactivity of mine wastes (e.g. waste rock, tailings, and overburden). Typical mine waste characterization studies employ laboratory and field leach tests (e.g., humidity cell tests) to quantify solute (e.g., sulfate, copper, nickel, etc.) release from mine wastes. In turn, the solute release data from leach tests is routinely used in water quality models for mining influenced waters. Despite this common practice, there has been a limited amount of work focused on quantifying the various hydrogeochemical processes under which these laboratory and field tests operate. These limitations can lead to large uncertainties in water quality model results and may result in improper use of solute release data for addressing the potential impacts of mine wastes to the environment.

In this method evaluation study, sulfide mineral reaction rates were calculated from reaction product coating thicknesses determined from microscope examination of weathered material from laboratory rock weathering experiments (e.g., humidity cell). Oxidation coating thickness measurements on pyrite grains from Minnesota taconite tailing basins, collected from a previous study, were also used to assess whether or not this explorative technique is applicable for natural settings. The study results indicated that this relatively simple and straightforward technique has the potential to accurately calculate the reaction rates of sulfide minerals from both laboratory experiments and naturally weathered mine wastes. Importantly, this study focused on calculating the rate of individual mineral reactions, whereas solute release data typically collected from laboratory weathering tests is a combined reaction signal from multiple unconstrained mineral reactions. Comparison of the sulfide reaction rates calculated in this study to sulfide mineral reaction rate laws from published literature values showed reasonable agreement, indicating this approach may be useful for quickly and accurately understanding the sulfide oxidation reactions occurring in field and laboratory settings. However, as an initial evaluation of the technique, the sulfide oxidation rates calculated in this report only serve as examples of the method approach and should not be used for predictive purposes. Further refinement and evaluation methods are identified that would improve the accuracy and reduce the uncertainty of the reaction rate values.