0. Executive Summary

The mitigative potential of subaqueous disposal for mine wastes containing sulfide minerals was examined using laboratory column tests in which sulfide-bearing rock was placed under water, and the water was sampled and analyzed. Placing sulfidic mine wastes under water (subaqueous disposal) might permanently prevent unacceptable solute release by reducing the rate of sulfide mineral oxidation. Addition of a barrier layer of material (e.g. taconite tailing) would be expected to further reduce the rate of sulfide mineral oxidation by inhibiting oxygen diffusion to the underlying mine waste. The present study determined rates of solute release from sulfidic waste rock beds disposed under water and quantified the effects of subaqueous disposal with oxygen diffusion barrier layers on sulfide mineral oxidation rates. Study results have clear application to sulfide-bearing mine waste in Minnesota.

Based on results from earlier laboratory batch experiments, two laboratory column experiments using Duluth Complex waste rock containing 0.8 – 1.2 % sulfur were initiated. First, oxygen transport limitation as a function of waste rock bed depth was examined. Results from this preliminary Bed Depth experiment indicated a minimum bed depth of 100-cm of coarse grained waste rock would be required for oxygen diffusion to limit rates of sulfate release in a subaqueous environment. This information was used to select the bed depth for coarse rock in an experiment examining the potential additional benefit of barriers above rock disposed in a subaqueous environment. The results were also used to conceptually exemplify the benefit of subaqueous disposal over subaerial disposal as a function of waste rock depth.

The second phase of column experiments examined the effectiveness of various taconite tailing barrier layers at inhibiting oxygen diffusion, and therefore, sulfide mineral oxidation in Duluth Complex waste rock in a subaqueous environment. Roughly three pore volumes of flow were required to remove reaction products released due to oxidation of the rock used prior to the inception of the experiment. This provides a basis for estimating removal of similar residual solute under operational conditions. The results indicated that a taconite tailing barrier of 5-cm was effective at reducing sulfide oxidation to 20% of that observed in the subaqueous control columns. Addition of a limestone layer above the tailing or composted yard waste mixed into the tailing did not provide any further reduction in oxidation rates. Comparison of the observed acid production rates from the columns to theoretical values calculated based on oxygen diffusion alone, indicated that the rate of acid production from waste beneath a 5-cm tailing barrier layer was probably diffusion-controlled. However, observed rates were higher than those predicted theoretically, possibly due to advective oxygen input in the experiment or erroneous assumptions in the theoretical application.