Accelerated precipitation of ochre for mine water remediation

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Metal-rich mine drainage is a worldwide environmental problem, its treatment can be passive or active. This paper discusses a series of laboratory scale experiments which investigated the accelerated precipitation of ochre for the treatment of metal-rich mine waters.

A variety of naturally occurring Fe oxy-hydroxides, a problematic waste material, have been collected from mine discharges. These were added to a range of mine waters to investigate accelerated precipitation of ochre as a remediation method. This removes Fe which co-precipitates elements from the drainage solution. The most effective "ochre", green rust (GR), is discussed here.

Results

Parys Mountain, N Wales, is an example of a metal-rich AMD discharge with a pH of 2.7. The raw water contains 75 mgL^{-1} Fe and 24 mgL^{-1} Zn. GR particles, at 5 gL^{-1}, were added, accelerating precipitation. Dissolved Fe and Zn were rapidly reduced to 12 and 5 mgL^{-1} respectively after 10 minutes, and to 6 and 2 mgL^{-1} respectively after 1 hour. The control, with no added particles, was not affected by exposure to the air alone and the concentrations remained constant.

The addition of particles to CMD from the Ynysarwed site in S Wales had similar effects. This site has an Fe concentration of 50 mgL^{-1}, a pH of 6, and 1.6 mgL^{-1} dissolved O_2. Air was added to innitiate precipitation. The control experiment showed a decrease in Fe concentration, caused by this addition of air. The Fe dropped to 48 mgL^{-1} after 10 minutes, and 40 mgL^{-1} after an hour. The addition of particles accelerated ochre precipitation; 5 gL^{-1} of GR particles caused the concentration of Fe to reduce to 13 mgL^{-1} after 10 minutes, and 6 mgL^{-1} after an hour.

Bwlch, a former Pb/Zn mine, has neutral (pH 6.6), low Fe (2.4 mgL^{-1}), high Zn (21 mgL^{-1}) discharge. $FeSO_4$ was added to give 40 mgL^{-1} Fe. The addition of 5 gL^{-1} GR particles enabled the resulting rapid precipitation of Fe to scavenge the Zn. The Zn was reduced to 0.3 mgL^{-1} after 10 minutes, and 0.1 mgL^{-1} after an hour. The Fe was returned to its original concentration after 10 minutes, and after an hour was reduced to 1 mgL^{-1}.

The accelerated precipitation of Fe has the potential to enhance passive and/ or active treatment of mine waters. The produced ochre can be recycled back into the system to encourage more precipitation of Fe oxy-hydroxides from these toxic mine waters. The rapid nature of the precipitation causes co-precipitated elements to be absorbed, which generates a more stable solid waste.