The use of redox pairs to model bioreactor processes in the treatment of acid mine drainage

M. FAIRGRAY [1], J. WEBSTER-BROWN [1], J. POPE [2] AND D. TRUMM [2]

[1] Waterways Centre for Freshwater Management, University of Canterbury, Christchurch 8140, NZ (marlese.fairgray@pg.canterbury.ac.nz, jenny.webster-brown@canterbury.ac.nz)

[2] CRL Energy Ltd, Christchurch 8024, NZ (j.pope@crl.co.nz, d.trumm@crl.co.nz)

Sulfate reducing bioreactors (SRBRs) have been shown to be effective at raising the pH of, and reducing metal loads in, acid mine drainage water. In order to model the speciation of trace elements and metal removal processes taking place in the SRBR, and the chemistry of the outflow from the SRBR, the pH and redox conditions of the system must be known. The redox conditions can be assessed using redox pairs, but there are many different options for redox pairs and it is important that the pair most representive of the true redox potential of the system is used for metal speciation and mineral stability modelling.

In this research, water samples from an abandoned coal mine drainage, a SRBR treatment system, and a stream receiving the mine drainage were collected, both before and after the installation of a SRBR. Four redox pairs were examined and their ability to predict the observed changes in metal chemistry assessed. Redox potentials calculated using Fe(II)/Fe(III) and NO_3^-/NH_4^+ were similar, whereas those calculated from the O_2/O^{2-} redox pair were higher, and those from the H_2S/SO_4^{2-} redox pair were consistently much lower.

Immediately below where the mine drainage water entered the stream, the redox conditions decreased slightly following the installation of the SRBR, but the cascading stream water quickly re-oxygenated. Of the iron oxide minerals predicted to precipitate in the stream environment (ferrihydrite, goethite, schwertmannite and jarosite), jarosite was not predicted to precipitate from the SRBR outflow. Metal sulfides such as chalcopyrite, covellite, galena, pyrite and sphalerite were predicted to precipitate in both the outflow of the tanks and in the stream immediately downstream of the outflow.