Treatment of acid mine drainage with mussel shell bioreactors – links between trace element geochemistry and microbial activity

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ABSTRACT

Mussel shell bioreactors treat acid mine drainage from coal mines in New Zealand. The shells provide a source of alkalinity; waste mussel meat provides a carbon source for SRB. With a downflow configuration, dissolution of shells results in precipitation of iron hydroxides on the top of the reactor, while reducing reactions deeper in the system form metal sulphides. In this study, an alternative design uses an up-flow configuration in an attempt to establish reducing conditions throughout the reactor and prevent the formation of iron hydroxides which can reduce permeability with time. Three reactors were constructed in series to treat pH 2.9 water dominated by Fe and containing a range of trace elements and sulphate. Trace element geochemistry and microbial community analysis show that metal precipitation is tied to microbial community diversity and there are distinct differences between the three reactors. The first reactor is dominated by iron sulphide precipitation and the microbial community is dominated by SRB but also contains many methanotrophs. In the second reactor, a wide range of trace element sulphides precipitate (including rarities such as cobalt sulphide and manganese sulphide) and the community contains some SRB but no methanotrophs. In the third reactor some trace element sulphides precipitate along with sulphates and carbonates and the community contains generic species such as bacterial halophiles of marine origin, and Firmicutes, such as soil bacteria of the Clostridia class (obligate anaerobes). Community composition and contributing genuses are discussed in detail and comparisons are made between community activity and metal precipitation.