Metal Removal Capabilities of Passive Bioreactor Systems: Effects of Organic Matter and Microbial Population Dynamics

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Motivation & Need

- All states in Region 8 have environmental problems associated with historic and current mining operations

Issues associated with environmental impacts include:

- Cost effective technologies to clean up mine waste sites

- Less costly and more rational clean–up strategies

RMRHSRC Research Goals & Approach

- **Goals:** Extend knowledge of the geochemical, biological, hydrological/mineralogical and engineering aspects of environmental problems associated with mining and mine wastes to develop new or improved methods that are cost effective and lead to clean ups that protect human health and the environment

- **Objectives:**
  - Characterize key processes
  - Quantify process kinetics
  - Calibrate coupled chemical/biological/physical models
  - Assess performance of treatment systems

- **Approach:**
  - Laboratory and field investigations
  - Aqueous and porous media systems
  - Reactor and system modeling

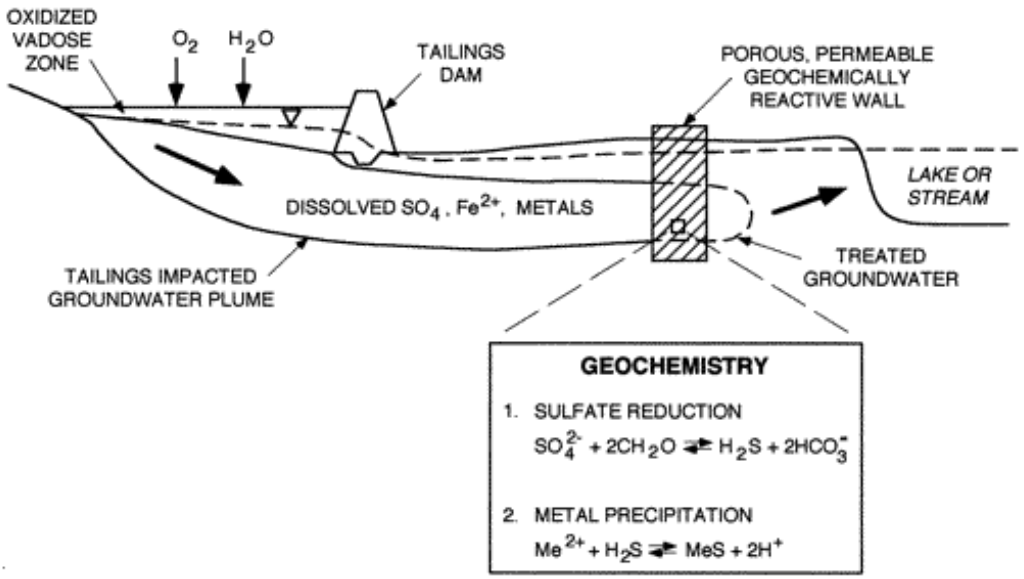
Abstract

- The ability of passive bioreactor systems (anaerobic wetlands, passive bioreactors and permeable reactive barriers)to remove metals from mine drainage has been demonstrated.

- However, problems arise with the performance of some passive bioreactor systems

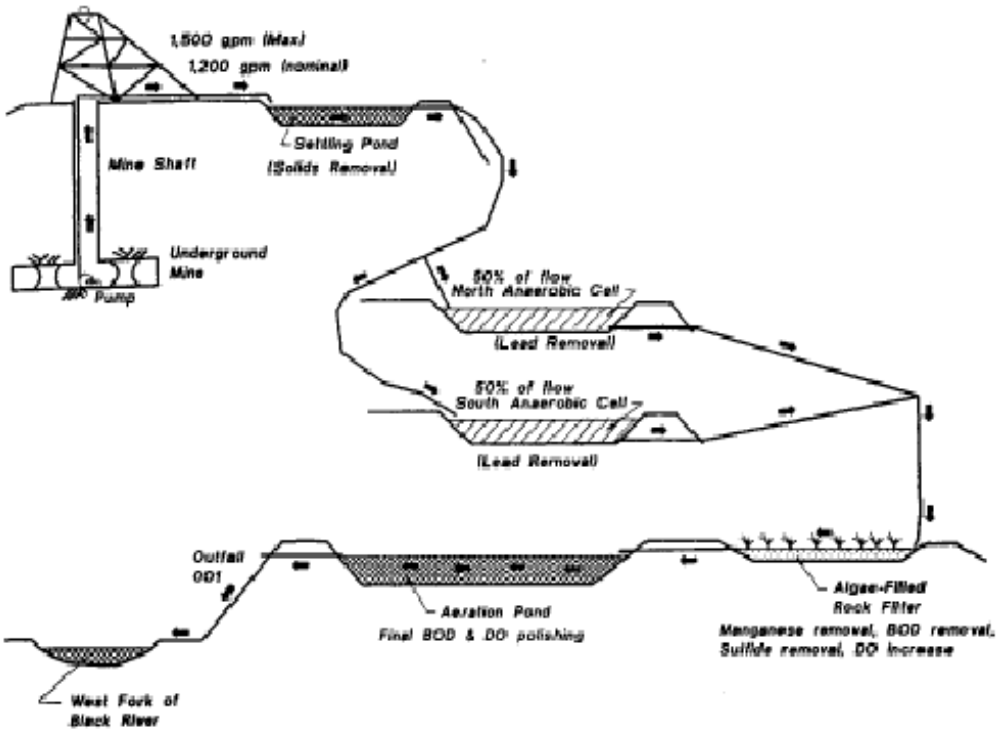
- The overall goal of this project is to improve process performance of these systems.

Passive barrier



Waybrant, Blowes and Ptacek 1998

Passive bioreactor



(Gusek, Wildeman, Miller and Fricke 1999)

Reported rates of sulfate reduction

0.14 - 4.27 mg/liter/day/gm organic matter
(Waybrant, Blowes and Ptacek 1998)

0.3 - 2.0 moles/cubic meter/day
(Wildeman, Gusek, Miller and Fricke 1999)

≥ 48 micromoles/mg/day
(Ludwig, McGregor, Blowes, Benner and Mountjoy 2002)

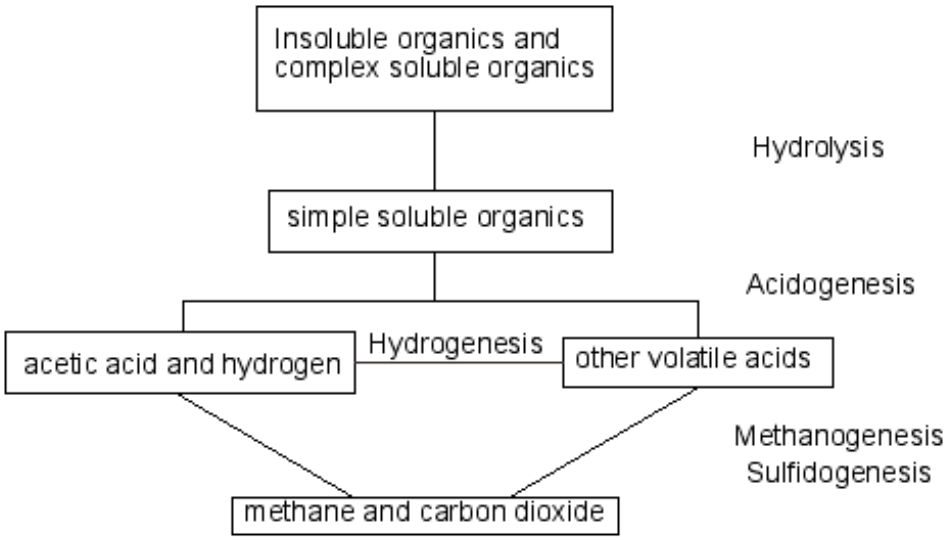
Reported substrate mixtures

15% leaf compost, 84% pea gravel, 1% limestone
(Ludwig, McGregor, Blowes, Benner and Mountjoy 2002)

20% leaf compost, 20% municipal compost,
10% wood chips, 50% pea gravel
(Waybrant, Blowes and Ptacek 1998)

25% year old dairy farm manure, 15% aged sawdust,
10% alfalfa, 50% limestone
(Gilbert, Wildeman and Ford 1999)

Microbial Processes



Passive system issues

- The role of other microbial populations in sustaining long-term sulfate reducing activity
- Organic substrate specification to ensure long-term sulfate reducing activity
- Complexation of metals by soluble organic products of microbial activity
- Toxicity of metals to important microbial functions
- Temperature effects on important microbial functions

Work Plan

1. Solid phase organic and inorganic material characterization (physical, chemical and microbial),

2. Batch studies on the effect of different PBR mixtures,

3. Bench-scale studies on the effect of selected substrate mixtures,

4. Field sampling of anaerobic wetland and passive bioreactor systems, and

5. Fate and transport modeling.

Expected Results

- Improved understanding of the microbial community structure and role in performance
- Improved organic substrate specifications
- Development of coupled physical/chemical/biological system model
- Improved designs of systems utilizing passive reactive biozones