Project Abstract: Rocky Mountain Regional HSRC Proposal (Figueroa, Ahmann, and Shackleford)

1. Title: Reactive transport modeling of metal removal from anaerobic biozones

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4. Project period: November 1, 2003 - October 31, 2005 (2 years)

5. Project costs: $271,494 ($206,581 Rocky Mountain Regional HSRC; $64,913 Cost Share)

6. Project summary:

Anaerobic biozones in wetlands, passive bioreactors and permeable reactive barriers remove metals from mine drainage via microbially facilitated precipitation of metals. Designed systems will typically perform well in the short-term but not in the long-term. We are currently developing tools to quantify the key components of organic substrates and the microbial community that is sustained by degradation of specific organic substrates for anaerobic biozones. We propose to continue development of a reactive transport model that incorporates the interactions between fermenters, sulfate reducers and methanogens and calibrate the model for key problematic metals (Zn, Cu, Cd and Pb) in Colorado streams. The overall goal of this project is to develop a model to describe the long-term microbial activity in anaerobic biozones.

a. Objectives: The overall goal of this project is to calibrate a model to describe the long-term microbial activity in anaerobic biozones. To achieve this goal, a research plan with the following objectives will be followed:

1. Complete development of the heterogeneous transport code with the biomodule,
2. Determine kinetic coefficients for model microorganisms, metals and substrates, and
3. Validate the model at a field-site.

b. Approach: The approach will utilize numerical techniques and experimental study in batch and column systems to test the proposed hypothesis and meet the project objectives. The project tasks are:

1. Develop and test computer code for heterogeneous component of a reactive transport model with biomodule
2. Calibrate model elements with controlled batch and column experiments, and
3. Validate model with field columns under variable influent temperature and metal concentrations.

c. Expected Results:

The complete numerical model will represent a new and powerful tool for the analysis of heavy-metals uptake from acid-mine drainage using sulfate-reducing biozones. Also, this numerical tool may be used to evaluate the results of laboratory column-test experiments that involve acid-mine drainage, organic-carbon substrates, and a population of SRB. The batch tests will establish the kinetic and adsorption coefficients for the model. The column tests will allow the calibration of the mass transfer coefficients need for the model. The results of the batch and column experiments will serve as inputs for the reactive transport model and the output of those models will be validated by comparison with experimental data. The results of the field column experiments and model validation will be used to design field-scale treatment systems to be tested in a subsequent project at Colorado site(s) with low temperature, at high altitude and with variable flow conditions.