# GEOCHEMICAL EVALUATION OF A PREMATURELY EXHAUSTED SULFATE-REDUCING BIOREACTOR; LACY SOUTH SITE, SOUTH-CENTRAL INDIANA[1]

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**Abstract:** A sulfate-reducing bioreactor was installed in May 2009 to treat a low-flow (ca. 5 L/min) acidic seep near the town of Shoals, Indiana. Initially the bioreactor performed well, completely sequestering the roughly 90 mg/L of incoming aluminum and converting 1,500 mg/L ($CaCO_3$ equivalent) acidity to a net alkalinity of 900 mg/L ($CaCO_3$ equivalent). However, by March 2010, the alkalinity of the outflow began to decline and the concentrations of major ions in the outflow began to increase. A tracer study (using bromide as the indicator) was conducted in May 2011 by which time the outflow was fluctuating between net acid and net alkaline conditions. The bromide tracer appeared in the outflow within 24 hours of injection, and water collected from several monitoring ports within the bioreactor showed that bromide followed a preferred (short circuit) pathway to the outflow. Calculations using inflow and outflow chemistry indicated that failure was occurring when less than 15 percent of the void space within the bioreactor was filled by reaction-generated solids. Subsequent exhumation revealed evidence of greater compaction in the inactive part of the bioreactor. However, flow data from the bioreactor suggests that compaction because of settling had achieved nominal conditions within 1 month of emplacement, whereas short-circuiting became evident approximately 1year later. Short-circuiting of the bioreactor can be attributed to changing conditions caused by mechanical compaction, pore-space filling because of precipitates, and dissolution of fill material. To address the contribution of each, samples of solids were collected from 12 locations and analyzed for metal precipitates, organic compounds, and sulfur isotopic composition to elucidate pore space transformations leading to premature bioreactor failure. The findings of this research point to the need to engineer flow paths through constructed bioreactors to increase their longevity as passive treatment systems.

**Additional Key Words** compaction, precipitates

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[1] Paper was presented at the 2012 National Meeting of the American Society of Mining and Reclamation, Tupelo, MS ***Sustainable Reclamation*** June 8 – 15, 2012. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502

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