Geochemical and microbial evaluation of the Tab Simco Treatment System

Y.T. SEGID[1], P.T. BEHUM[2]*, K.S. BENDER[3], C.C. PUGH[3], A.S. BURNS[3] AND L. LEFTICARIU[1,2]*

[1]Department of Geology, Southern Illinois University, Carbondale, IL 62901, USA
[2]Environmental Resources and Policy Program, Southern Illinois University, Carbondale, IL 62901, USA (*correspondence: pbehum@siu.edu) (lefticariu@geo.siu.edu)
[3]Department of Microbiology, Southern Illinois University, Carbondale, IL 62901, USA

Acid mine drainage (AMD) is a widespread environmental problem in Illinois basin, where extensive coal mining was carried out during the last century. Passive treatment is an important technology for remediation of streams impacted by coal mining. Understanding the geochemical and biologic processes is the key to designing effective AMD treatment systems. This research team is investigating the Tab-Simco AMD tretment system. Chemical analyses indicated that the passive bioreactor increases pH from 2.8 to 6.4, and decreases acidity from 3,386 to 74.4 mg/L, sulphate from 4590 to 2020 mg/L, total Fe from 884 to 3.48 mg/l, Mn from 34.47 to 26.40 mg/l, and Al from 207.4 to 2.10 mg/l. In the bioreactor alkalinity is generated by both limestone dissolution and bacterial sulfate reduction.

Microbiological profiling of the site was performed by molecular analysis of the 16S rRNA gene clone libraries. This analysis indicated an abundance of sequences closely related to bacteria capable of Fe^{2+} oxidation in waters from both the monitoring wells and the constructed AMD oxidation pond. Sequences closely related to *Acidithiobacillus ferrooxidans*, an organism that can not only oxidize Fe^{2+} but can also couple Fe^{3+} reduction to the oxidation of sulfur, is found in seeps that feed the bioreactor. The predominant phylotypes present in the samples collected from the bioreactor discharge post-treatment oxidation pond were related to a sulfur and Fe^{2+} oxidizing bacteria. However, sequences related to bacteria necessary for metabolizing the compost into simple carbon sources (a requirement by sulfate-reducing bacteria-SRB) were identified. To determine if SRB were present at the site, but in numbers too low to be detected by the initial sampling size, the *dsr*AB gene specific for sulfate-reducing bacteria was targeted. Sequences related to SRB were present in the bioreactor outlet and the post-treatment pond. These results will be used to improve bioreactor design and ultimately the water quality at the AMD treatment site.

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Geomorphic controls on nitrate processing in a freshwater tidal marsh invaded by *Hydrilla* sp., Patuxent River, MD

E. SELDOMRIDGE AND K.L. PRESTEGAARD

University of Maryland, Department of Geology, College Park, MD 20742, USA (eseldom@umd.edu, kpresto@geol.umd.edu)

Freshwater tidal marshes, located at the upstream end of estuarine systems, can be important sites for denitrification and other biogeochemical transformations. These marshes, however, are susceptible to changes in climate with consequent sea level rise and shift in species composition. In this study, we examined the delivery and processing of nutrient-rich waters in tidal marshes that have been invaded by non-native submerged aquatic species of *Hydrilla*. The geomorphic and hydrologic characteristics of the marsh surface and channel networks were used as a framework for sampling nutrient fluxes. In this study, field measurements were made to calculate water and nitrate flux for stream channels of varying order.

The mass balance measurements indicate that there is an exponential increase in net nitrate retention with channel order. The increase is similar to that of marsh area with stream order, but high order tidal marshes process proportionally less nitrate per surface area than small marshes. This suggests that biogeochemical processing may be limited by the amount of water and nitrate that can be brought into the marsh, which is controlled by the marsh channel hydraulics. The larger tidal channels are covered seasonally with *Hydrilla,* which significantly reduces the average channel velocity, and thus the total flux of water and nitrate into the tidal marshes. This reduction of water flux into the marsh may be responsible for the decreased nitrate processing in interior marsh sites. Comparison of total nitrate loss and *in situ* measurements of denitrification rates in marsh cores suggests that additional processes are responsible for some of the nitrate retention.