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Project Title

Impact of Landfill Leachate on Iron Release from Northest Florida Iron Rich Soils

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Third Progress Report

(February 1, 2006 to April 30, 2007)

Submitted to

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1. Introduction

For this part of our research, we surveyed and sampled soil and leachate samples from landfill sites in 12 counties of Northwest Florida. We then conducted laboratory batch experiments to simulate iron transformation processes. Specifically, we reacted soil samples collected from landfill sites with corresponding leachate in the presence of cultured iron reducing bacteria. We monitored iron transformation in these reactors on a daily basis. Since the soil iron content varies from county to county, and so does the leachate composition, variable iron release is suspected to be observed for different soil and leachate samples. We report here the results of aqueous iron concentration after iron-rich soil reacted with the corresponding landfill leachate in the presence of iron reducing bacteria. Please be noted that some of the experiments are still proceeding.

2. Objectives

Our objective for this part of research is to provide evidence whether, and if yes, to what extent, iron can be released from the iron-rich soil when the soil reacts with the landfill leachate in the presence of iron reducing bacteria.

3. Project Progress

3.1 Soil and Leachate Sample Collection

Soil and leachate samples were collected from 12 counties in Northwest Florida. For each county, we selected a typical landfill and sampled both the soil and the leachate. We used direct push technologies (e.g., cone penetrometer) to sample the soil at the target site. Soil samples were labeled with the appropriate date and sampling location and were taken to the lab for analysis immediately following sampling. During transportation, the soil samples were stored in temperature-controlled containers or in a sealed ice chest. If ice was used, ice was placed in separate plastic bags and sealed. For the leachate samples, we collected leachate from the sampling wells of each landfill. Typical site sampling pictures are shown below.

Santa Rosa Central Landfill

Holmes County Landfill

Franklin County Central

Steelfield Landfill, Bay County

Spring Hill South landfill, Jackson County

Leon County Landfill

3.2 Laboratory Iron Reduction Experiments

Laboratory iron reduction experiments are currently being conducted using soil samples collected from landfill sites reacting with the corresponding leachate under chemistry and biology conditions similar to the concerned site in the presence of cultured iron reducing bacteria. All the experiments are being conducted in a sealed glass reaction vessel in the anaerobic chamber to mimic the situations in the subsurface where landfill leachate interacts with the soil. As a control, sampled soil also reacts with simulated storm runoffs. We monitor ferrous iron, ferric iron, and pH, etc. on a daily basis. Results are shown in Figure 1.

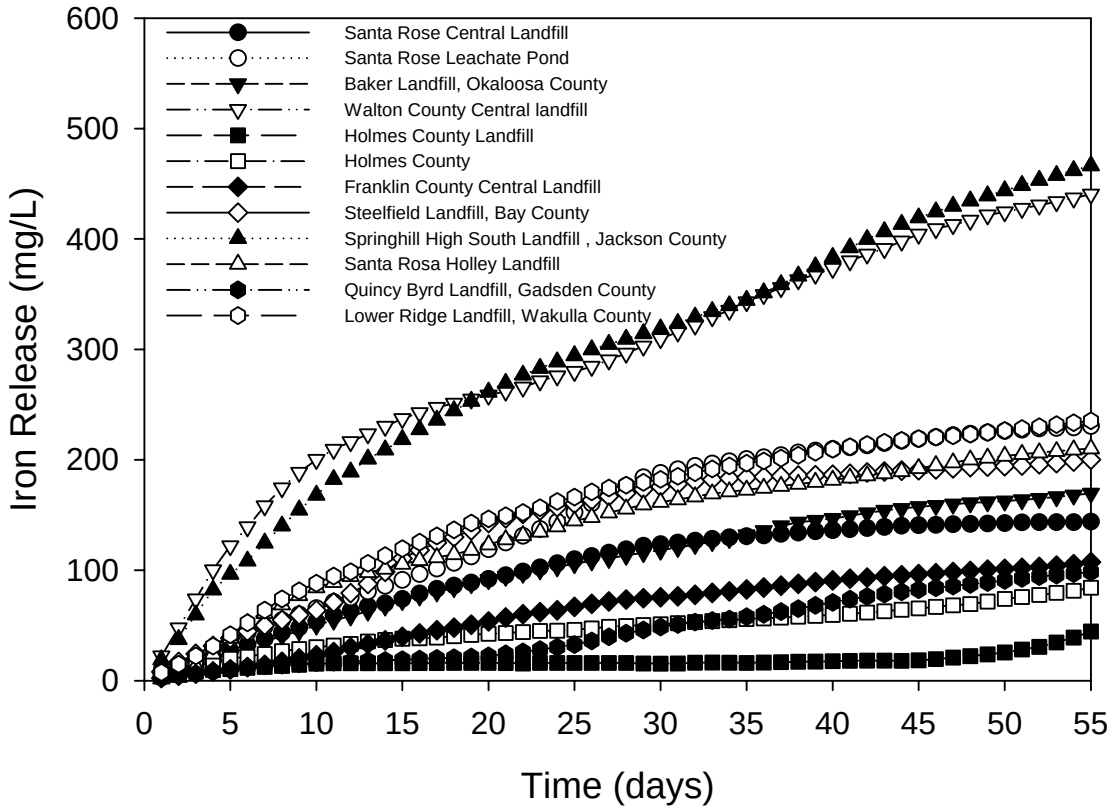

Figure 1. Laboratory Batch Experiments Using Soil Samples Collected from Landfill Sites Reacting with Corresponding Landfill Leachate

Iron release was most pronounced for soil samples collected from Jackson County (Spring Hill South Landfill) reacting with the corresponding landfill leachate. The iron release for this site can be as high as 450 mg/L within 55 days. Following Jackson County is the soil sample collected from Walton County, which produced iron release at a concentration of 420 mg/L within 55 days of reaction. All the other samples produced less than 200 mg/L of iron release. It should be noted that these reactions all occurred in the presence of iron-reducing bacteria pre-cultured using the iron-rich soil as base consortia.

It is suspected that microbial mediated iron reduction should follow the following reaction:

$$CH_2O + 2Fe_2O_3 + 3H_2O = CO_2 + 4Fe^{2+} + 8OH^-$$

Consequently, pH of the solutions in the reactors should increase with the proceeding of the reactions. Our monitored results are consistent with above prediction except for reactions using the soil samples collected from Baker County Landfill. Instead of increase, pH decreased

with the proceeding of the reactions. We are still investigating the reason why it happened this way. By monitoring the pH variation, we found that the pH of the leachate was very low for Walton County Central Landfill. The low pH favored the iron reduction process as described above. Consequently, higher iron release was observed for these samples.

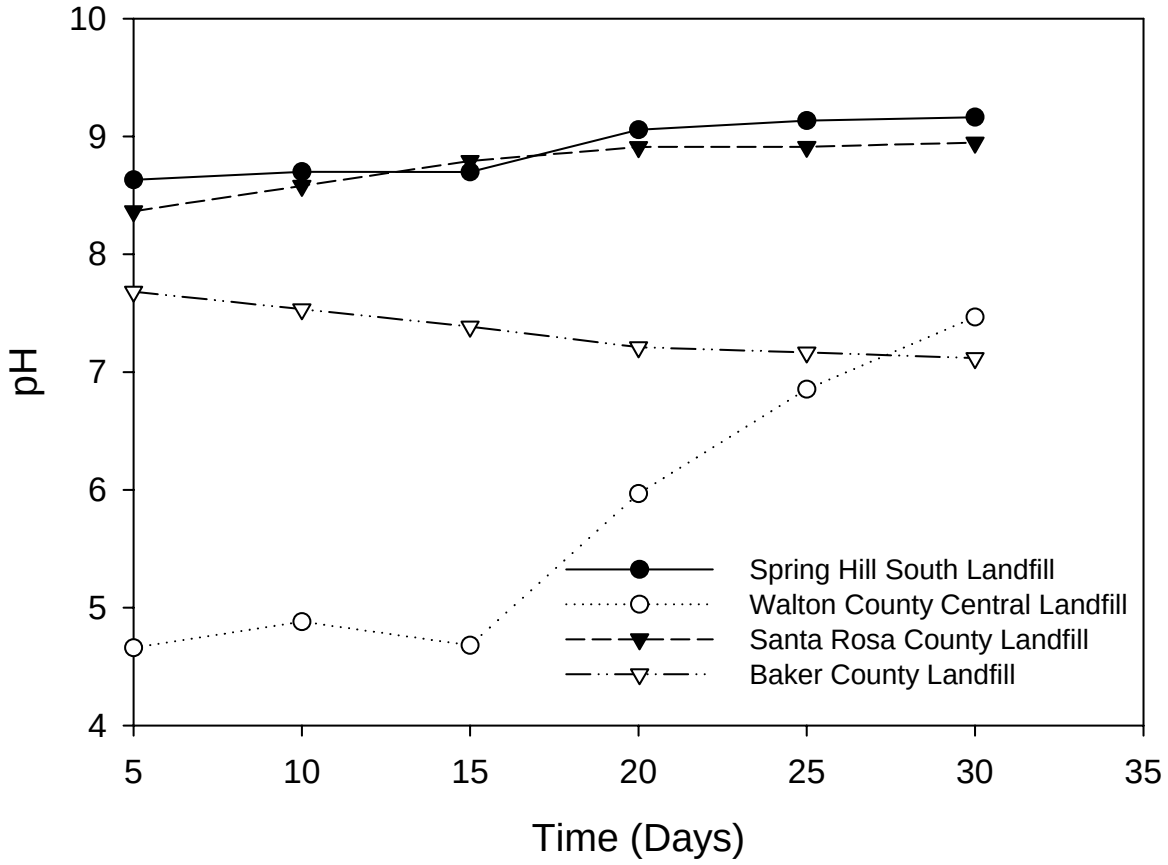

Figure 2. pH Profile of the Batch Reaction

4. Future work

4.1 Column Experiments

We will conduct the following column experiments to simulate the kinetic iron release processes (Figure 3). The column experiments will be conducted using the bulk soil sampled at Santa Rose Central Landfill. The column will be sprinkled with corresponding landfill leachate to mimic situation actually occurring underneath the landfills. The column will be sampled at different depth regularly for ferrous iron, ferric iron, dissolved oxygen, pH, and redox potential, etc. We suspect that the oxygen profile in the column should have an impact on iron release within the column. Since iron release is believed to be a microbial mediated iron reduction process, more iron release is expected from the lower section of the column where oxygen content is lower.

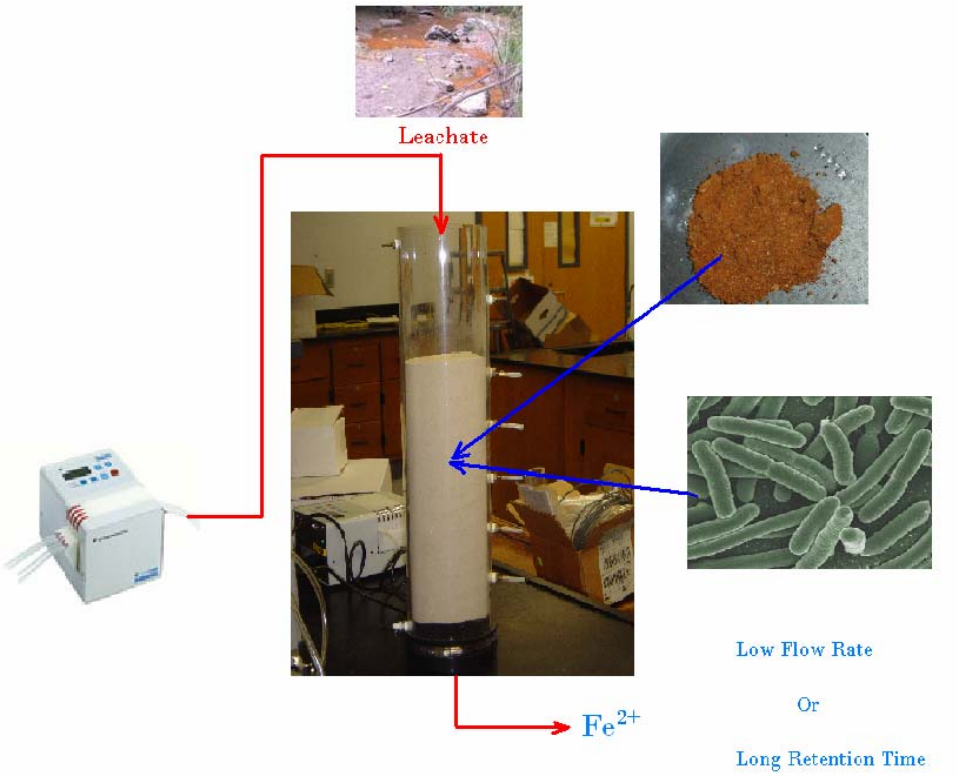

Figure 3. Column Iron Release Experiments in the Presence of Landfill Leachate

5. Miscellaneous

We have set up a website (www.eng.fsu.edu/~gchen) for this project to facilitate the dissemination of our research discovery. We have also presented part of our ongoing research at IRON AT LANDFIILS convened at Destin on October 18, 2006. We had the first TAG meeting on October 13, 2006. Our second TAG meeting is scheduled on May 14, 2007. Currently, we have one paper published in Colloids and Surfaces A: Physicochemical and Engineering Aspects (doi:10.1016/j.colsurfa.2007.02.063). We acknowledged the work was support in part by Florida Center for Solid and Hazardous Waste Management. Detailed information of the project is available at www.eng.fsu.edu/~gchen.

Appendix