

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

Gang Chen, Tarek Abichou , and Jeffrey Chanton

**Department of Civil and Environmental Engineering
FAMU-FSU College of Engineering
Department of Oceanography
Florida State University**

Iron Release in NW Florida



**Central Landfill
Walton County**



**Fairgrounds Branch below
Auto Shred Landfill**

Visible Iron Release near Landfills



Roles of Microorganisms in Iron Release



**Coffee Creek
Beulah Landfill**



NW Florida Iron Rich Soil

Iron/Sulfur Bacteria Growth from Unlined Landfills

Evidence from Leon County Landfill



Percolation from lysimeter with soil and organic matter (Note: darker color or more concentrated iron observation)



Percolation from lysimeter with soil only

Objectives

- **Explore geochemical and geomicrobiological iron reduction/oxidation processes**
- **Elucidate dominating iron release mechanism from iron rich soils near landfills**
- **Long-term goal**
 - Derive the relationship of iron reduction/oxidation processes with the hydrogeochemistry and geomicrobiology
 - Develop modeling tools to predict and monitor iron reduction/oxidation and release processes

Outline

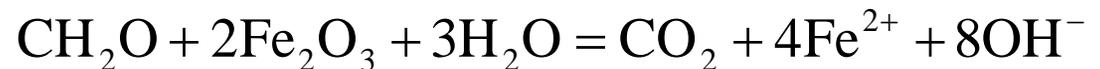
- **Available data analysis**
- **Possible iron release mechanisms**
- **Current work**
 - Landfill leachate simulation
 - Microbial culture cultivation
- **Future work**
 - Laboratory iron reduction experiments
- **Suggestions**
 - Soil sampling
 - Support for further funding application

Iron-Reducing Bacteria

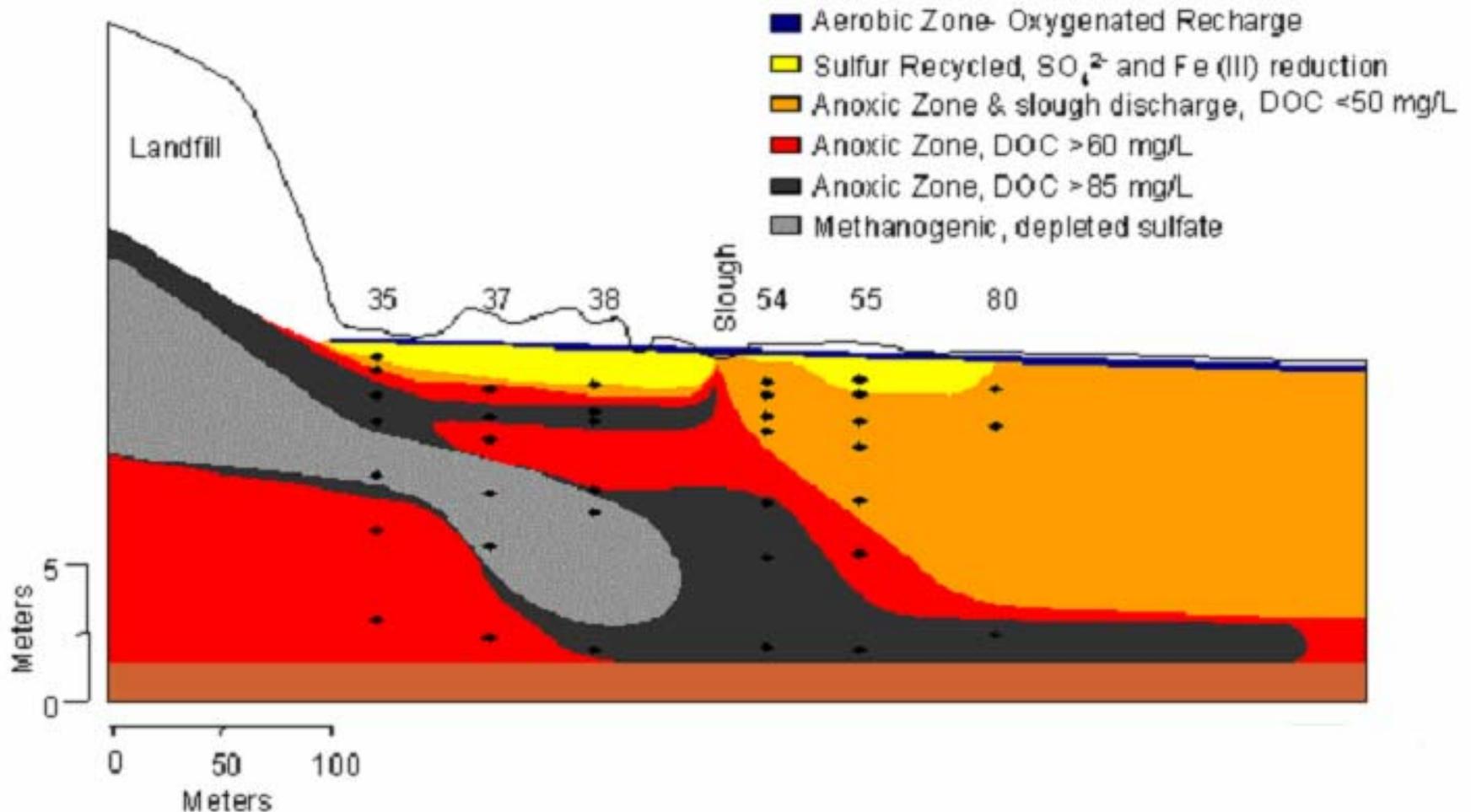


Shewanella oneidensis
strain MR-1 growing on
the surface of the iron
oxide mineral hematite

- Iron-reducing bacteria to reduce iron oxides to ferrous iron
- *Shewanella oneidensis* strain MR-1 to conserve energy for growth with the structure Fe(III) bound in smectite clay
- Most of the iron on earth in the form of silicate minerals or iron oxides

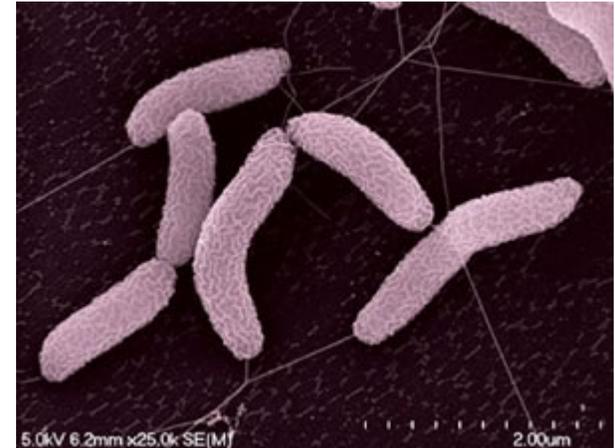


Thermodynamic Consideration



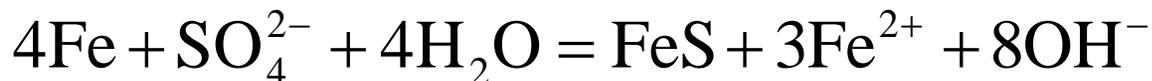
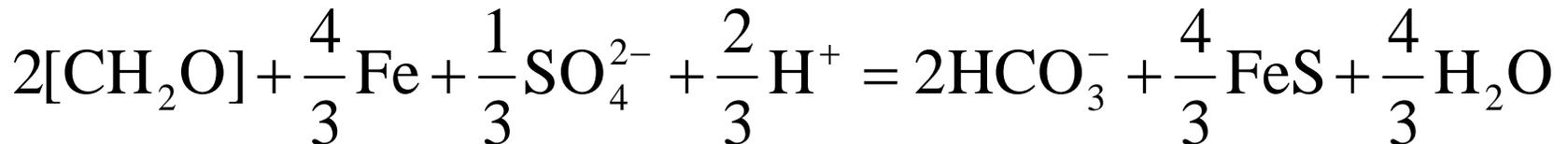
Sulfate-Reducing Bacteria

- Sulfate-reducing bacteria responsible for pitting the iron
- Indirect mechanism



*Desulfovibrio
desulfuricans*

- Direct mechanism



Possible Iron Release Mechanisms

High Organic Content



Leon County Landfill



Landfill Leachate



Elevated Iron Release

Iron Reduction

Iron Rich Soil



Possible Iron Release Mechanisms



Metallic Iron



Leon County Landfill



Landfill Leachate

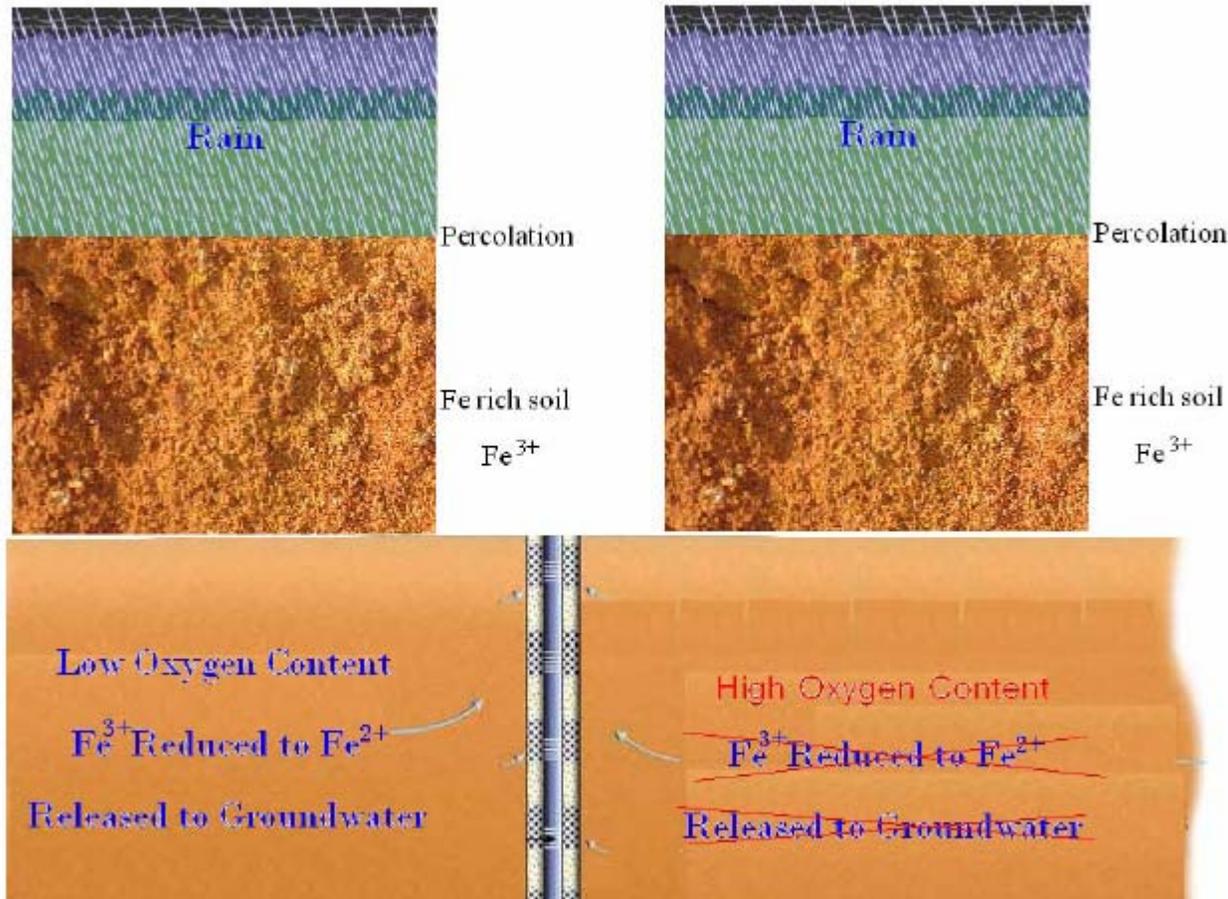


H₂S Production

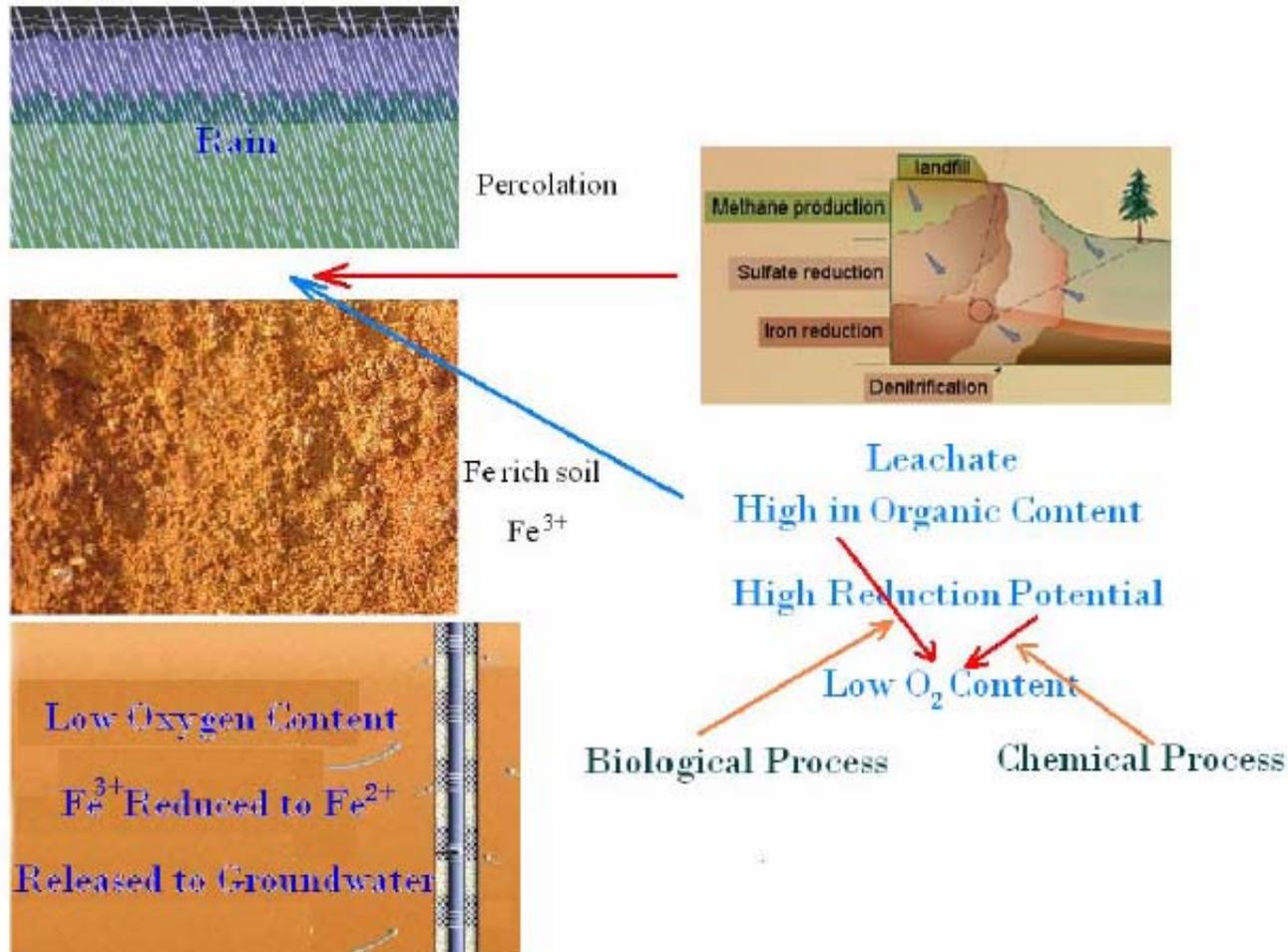
Elevated Iron Release

Iron Oxidation

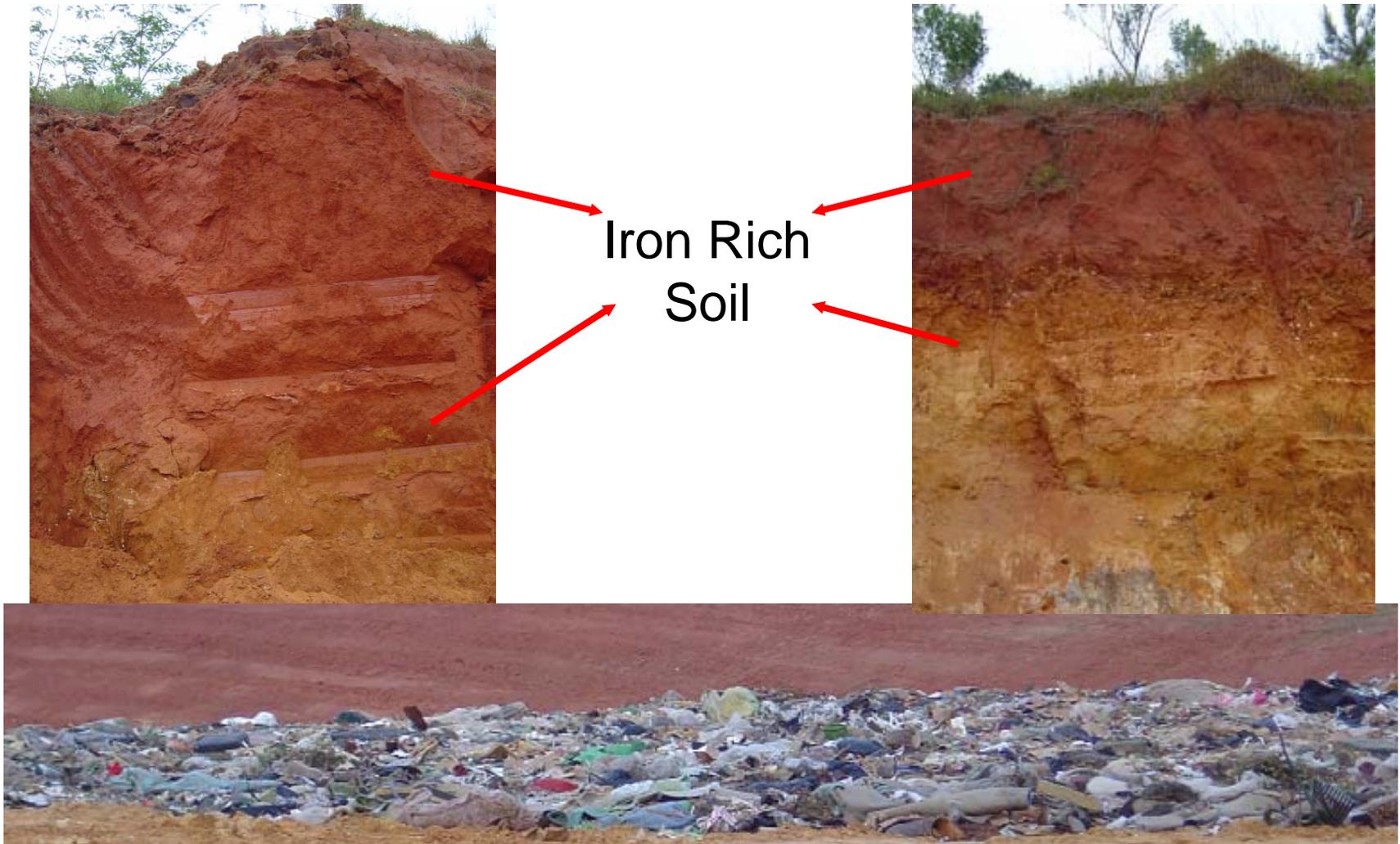
Possible iron release mechanisms



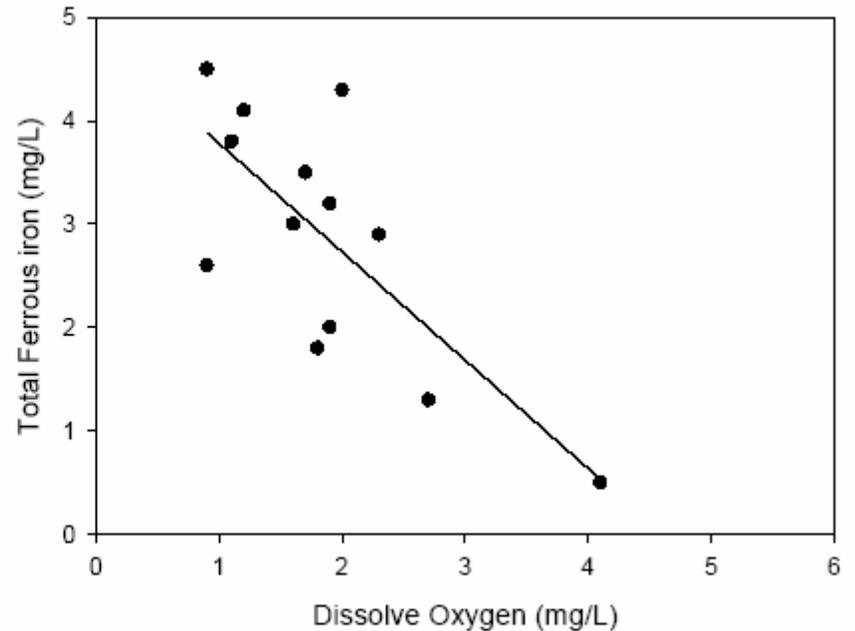
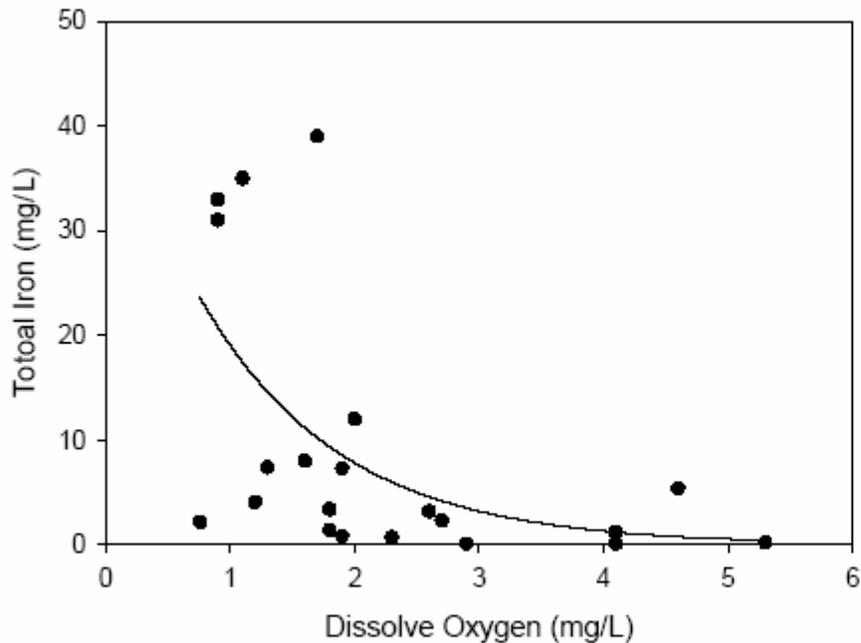
Possible iron release mechanisms



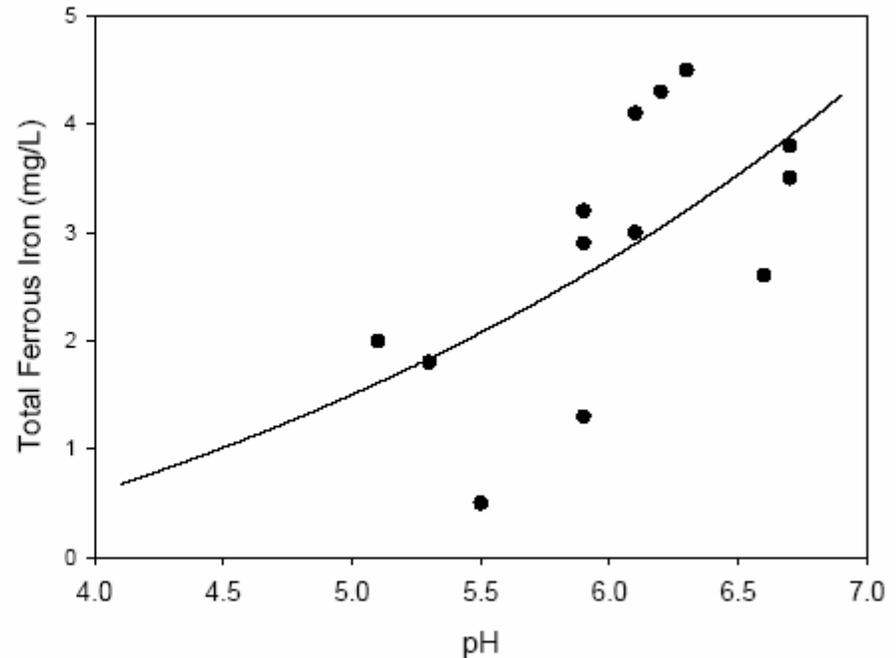
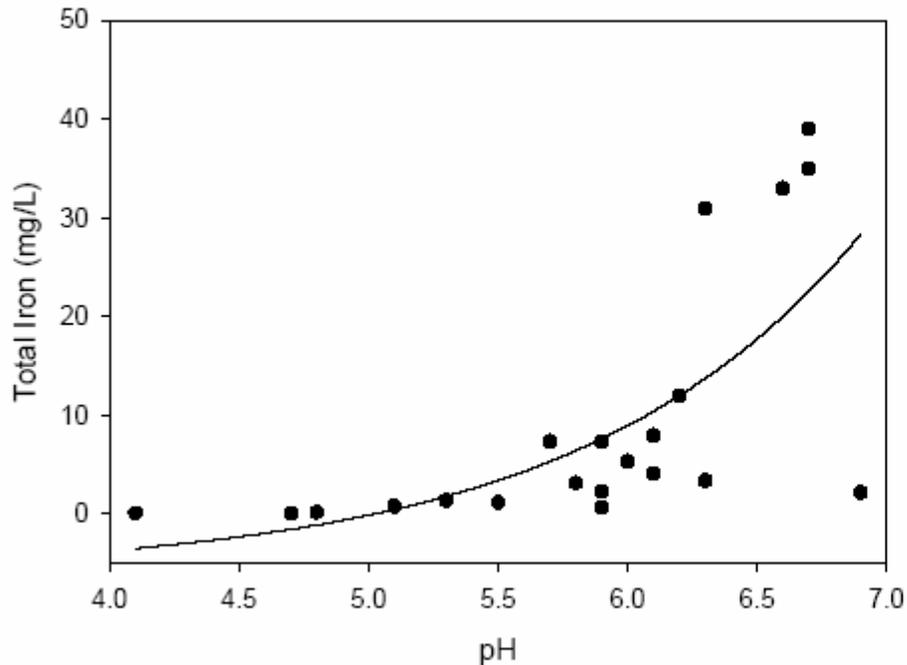
Leon County Landfill Soil Profile



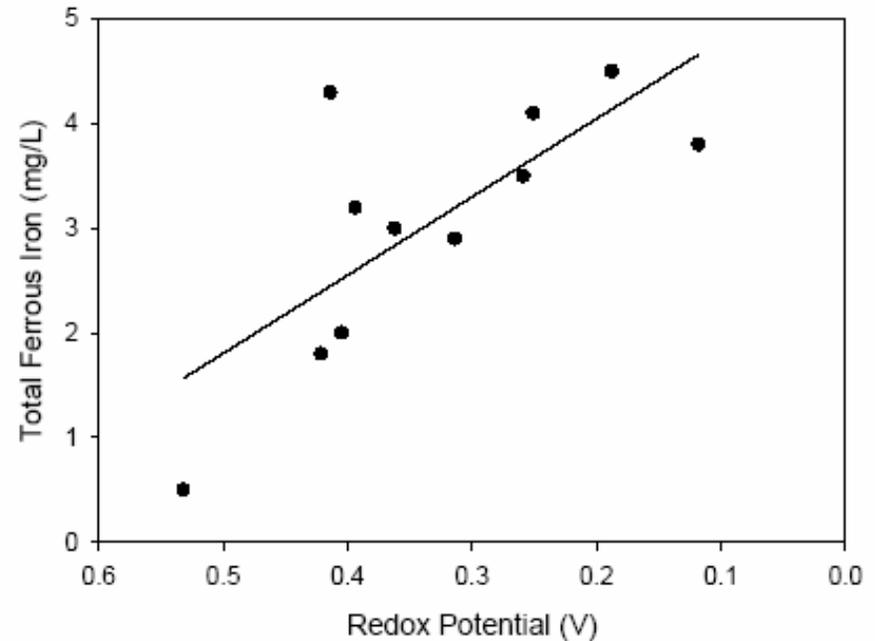
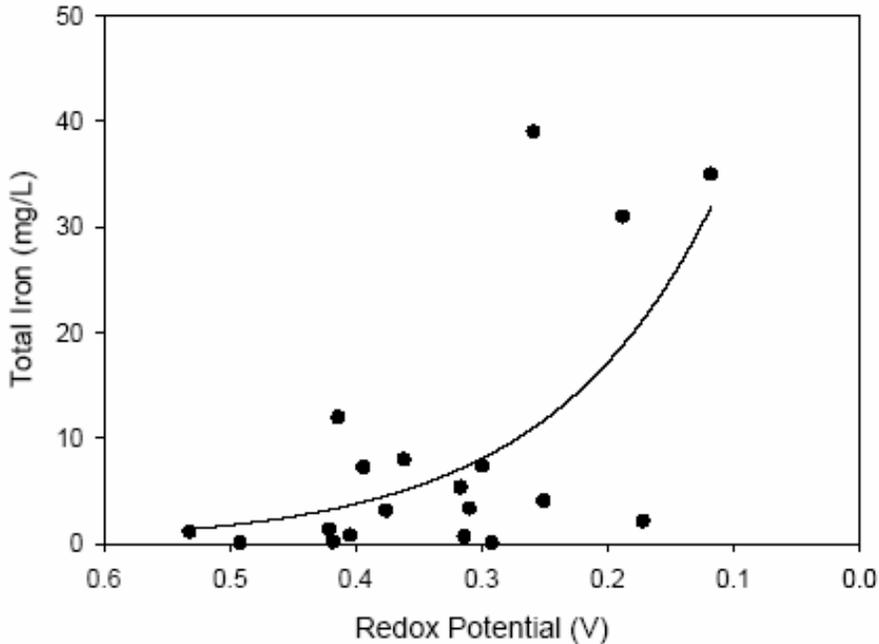
Available Data from Majette Landfill



Available Data from Majette Landfill



Available Data from Majette Landfill



Preliminary Conclusion

- **Microbial mediated iron reduction**
- **Mixed culture**
- **Aerobic for oxygen depletion**
 - Reduction of iron occurs under highly reduced anaerobic conditions
- **Anaerobic iron reducing bacteria**

Aerobic Bacteria Culturing



Aerobic Bacteria Culturing



Anaerobic Culture Cultivation



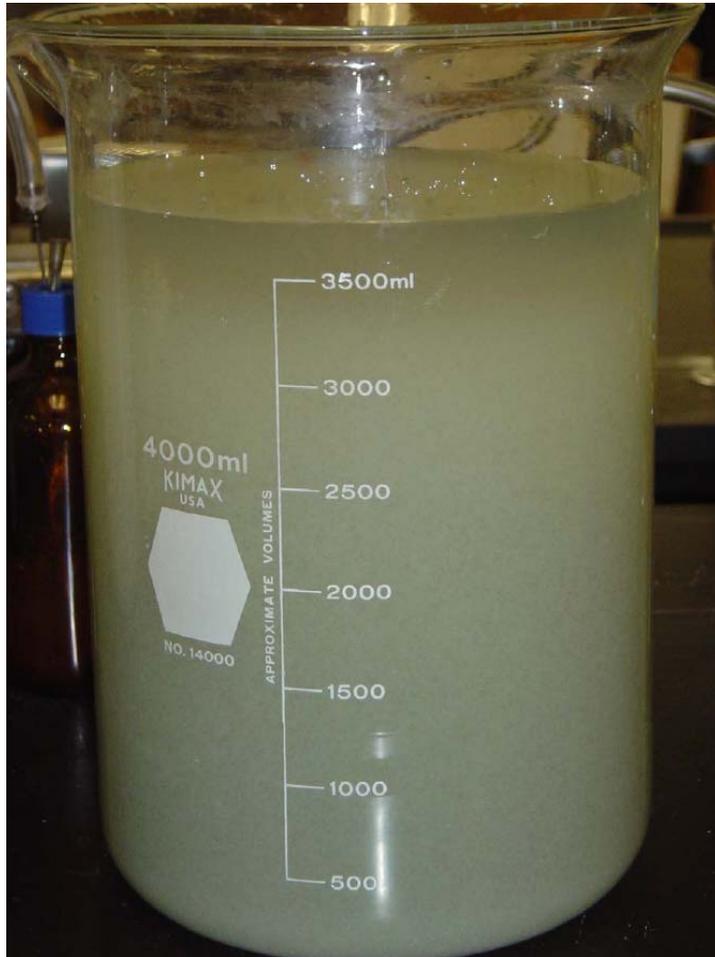
- **Sampled soil as base consortium**
- **Under anaerobic conditions**
- **Teflon-sealed container equipped with CO₂ entrapping devices**
- **Mineral salts medium**
- **Glucose as carbon source**
- **In the presence of simulated leachate and $\text{Fe}_2(\text{SO}_4)_3 \cdot 7\text{H}_2\text{O}$**



Anaerobic Bacteria Culturing



Leachate Simulation



- **Artificial leachate simulation**
 - pH
 - Oxidation-reduction potential
 - Dissolved oxygen
 - Major solution cations (Na^+ , K^+ , Mg^{2+} , and Ca^{2+} , etc.)
 - Major solution anions (Cl^- , NO_3^- , SO_4^{2-} , PO_4^{3-} , F^- , and S^{2-} , etc.)
 - Organic matter

Future Work



Fe^{2+} O_2 Content

Day 1 = ?

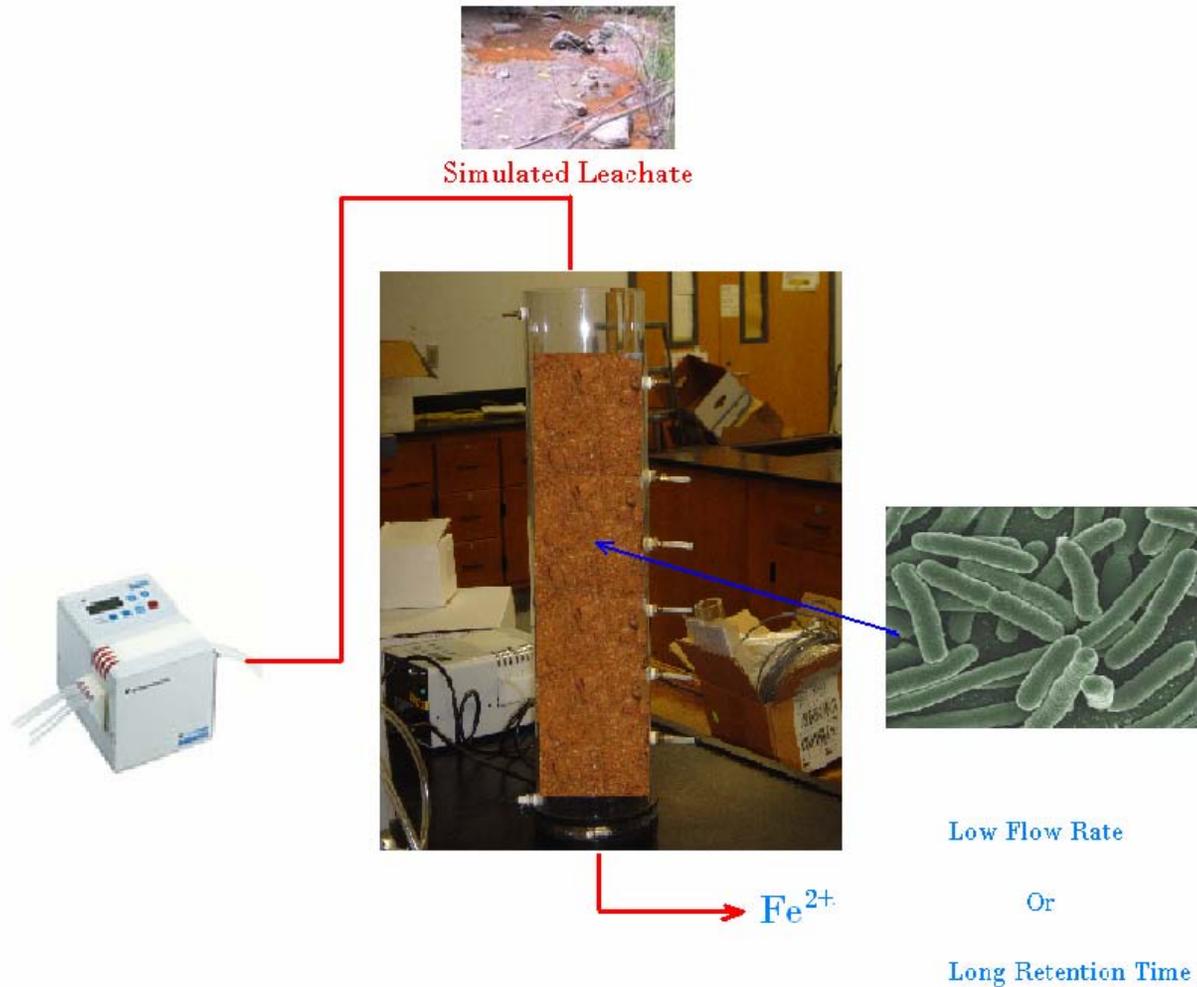
Day 15 = ?

Day 60 = ?

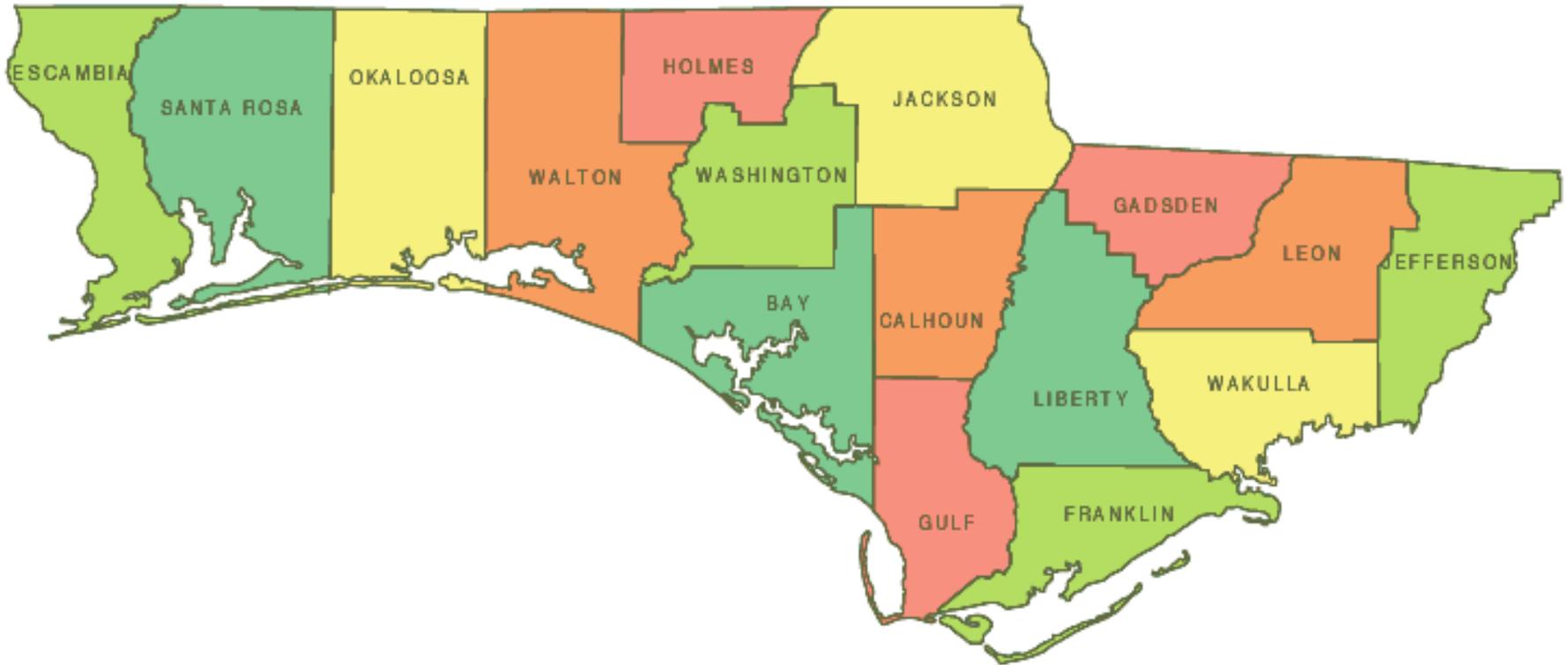


Simulated Leachate

Future Work



Soil Sampling Location



Support for Funding Acquisition from EPA

AGENCY: ENVIRONMENTAL PROTECTION AGENCY (EPA)

TITLE: “OSWER INNOVATIONS PILOT PROJECTS”

ACTION: Request for Applications (RFA) - Initial Announcement

RFA NO: EPA-OSWER-IO-06-08

Cooperative Partners. Provide names and phone numbers of individuals and organizations that have agreed to participate in the implementation of the project:

Letters of support from any partners involved with the proposal. **If the applicant is including cooperative partners as part of the project team, a letter of support from each cooperative partner is required.** The letter must be on the partner’s letterhead and must be signed by a responsible official of the partner organization stating their intention to work on and/or contribute funds to the project including an estimate of the funding and time commitment. Letters of support must be provided to document any matching or supplemental funds that are described in the proposal. Letters of support must be received by the closing date and time for receipt of applications under this announcement.

Questions?
