Connecting microbial activity and sulfate reduction in Louisiana salt marshes

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Background

- The ocean is a major reservoir for Earth's sulfur, mainly in its most stable form of dissolved sulfate. In marine ecosystems, the sulfur cycle is coupled to carbon remineralization. Sulfur compounds are important electron donors (oxidation) or electron acceptors (reduction) for deep-sea and subsurface sediment bacteria; ~80% of subsurface sulfate reduction occurs on continental shelves, with ~30% occurring in shallow depths (0-10m)[1]. Since coastal and shelf sediments experience some of the highest rates of sulfate reduction, they are the ones impacted the most by climate change and other anthropogenic influences

Objective

- To assess microbial activity and sulfate reduction within Louisiana salt marshes.
  - Hypothesis: Sulfate reduction rates will follow in situ sulfate concentrations and decrease with depth

Site Map

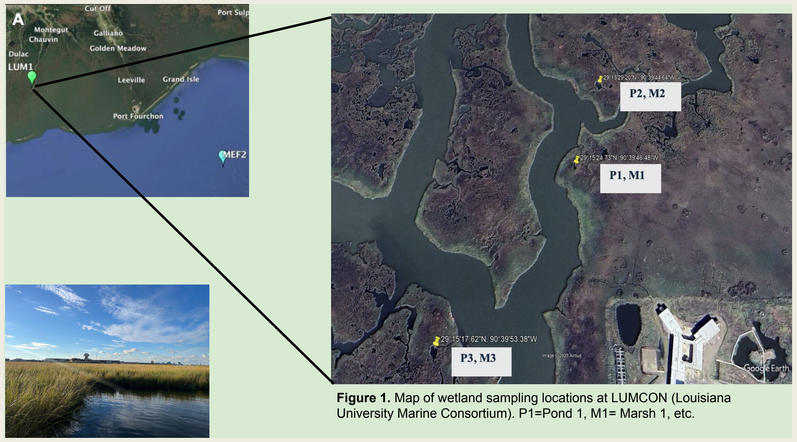
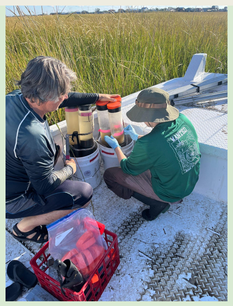


Figure 1. Map of wetland sampling locations at LUMCON (Louisiana University Marine Consortium). P1=Pond 1, M1= Marsh 1, etc.

Sampling Methods



Sediment cores within the acrylic core liners were sealed and stored in site water before being transported back to the lab for sectioning.

Sediment was extruded in 5 cm increments and sectioned into whirls paks and then immediately store in a -80°C freezer.

Methods

- Sediment samples collected from three shallow ponds (~0.2-0.5 m depth) and adjacent marshes, using an acrylic core liner and a Russian peat corer.
- Pore water from each core was collected with depth for sulfate, dissolved inorganic carbon, methane, and chloride.
- Radiotracers ($^{35}SO_4^{-2}$) measured sulfate reduction rates from only pond cores using cold chromium distillation in triplicate [2].
- DNA and RNA were extracted using a Qiagen RNeasy PowerSoil Total RNA Kit and DNA Elution Kit.

Figure 2. Cold chromium distillation method setup.

Figure 3. Pore water collection.

Geochemistry Profiles

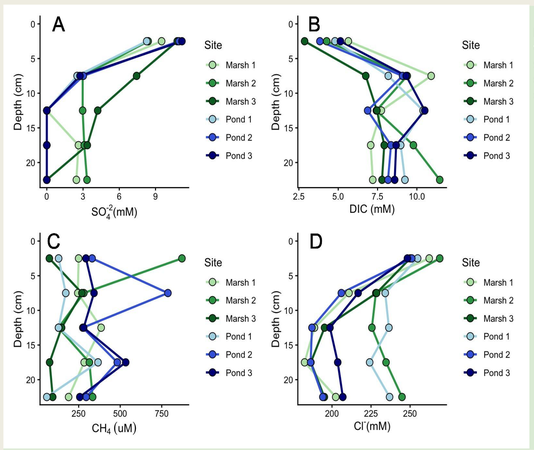


Figure 4. Insitu geochemical profiles with depth collected from pore water samples for all six sites. A. sulfate concentration B. dissolved inorganic carbon (DIC) C. methane D. chloride.

Chloride:Sulfate Ratio

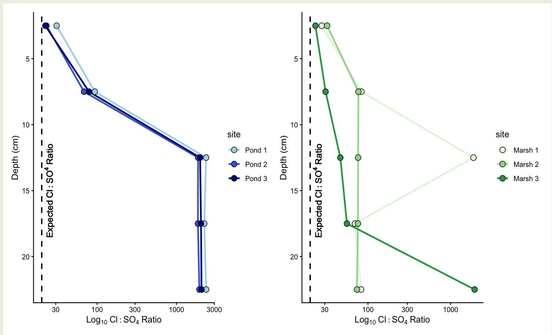


Figure 5. $Cl^-:SO_4^{2-}$ ratio with depth from all three pond and marsh sites. Dotted line represents the 20:1 ratio expected from sea water. Ratios larger than 100 were due to sulfate concentrations being below detection and a sulfate detection limit of 0.1 was assigned for calculation

- Typical chloride to sulfate ratio of seawater is 20:1.
- Plotting $Cl:SO_4^{2-}$ was done to ensure that the sulfate reduction we observed was a true drawdown and not due to tidal influences.

Sulfate Reduction Rates (SRR)

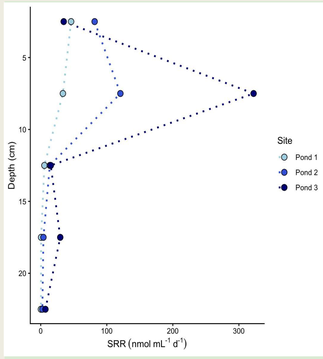
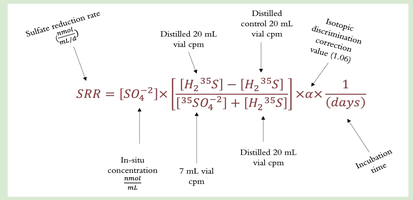


Figure 6. Sulfate reduction rates average (nmol mL^{-1} d^{-1}) with depth from three pond sites

- SRR peaked once the sediment became anoxic and quickly declined as sulfate was consumed.



Eq 1. Sulfate reduction rate equation

Discussion

- The geochemical profiles of the pore water showed clear depth-dependent changes in chloride, sulfate, methane, and DIC in both the pond and marsh sediments.
- **Fig. 5** further shows that the observed drawdowns in sulfate concentrations are not tidally driven and likely microbially driven.
- We hypothesized that we would see a decrease in sulfate reduction rates as it follows the depth gradient due to the decrease in sulfate concentrations and in **Fig. 6** followed that trend is seen in the pond site samples.

Outlook

- DNA and RNA extractions and sequencing has been done for all sites and depths and is currently in the bioinformatics stage.
- Future steps will focus on characterizing the composition and abundance of sulfate-reducing microbial communities through quantifying *dsrA* gene expression.
- By combining sulfate reduction rates with *dsrA* gene expression, analyses will help reveal which microbial populations drive sulfur transformations and how their activity influences carbon degradation in salt marsh sediments.

Citations

1. Jørgensen, B., Findlay, A., & Pellerin, A. (2019). The Biogeochemical Sulfur Cycle of Marine Sediments. *Frontiers in Microbiology*, *10*, 849. https://doi.org/10.3389/fmicb.2019.00849
2. Røy, H., Weber, H. S., Tarpgaard, I. H., Ferdelman, T. G., & Jørgensen, B. B. (2014). Determination of dissimilatory sulfate reduction rates in marine sediment via radioactive^{35}S tracer. *Limnology and Oceanography: Methods*, *12*(4), 196–211. https://doi.org/10.4319/lom.2014.12.196

Acknowledgements

Funding for this project was provided by the National Science Foundation (Grant # 231239)