O2 microsensor profiling conducted alongside the destructive sampling of Chesapeake Bay sediments during incubation experiments at Horn Point Lab

Website: https://www.bco-dmo.org/dataset/883412
Data Type: Other Field Results
Version: 1
Version Date: 2022-11-08

Project
» Collaborative Research: Probing the Metabolic and Electrical Interactions of Cable Bacteria in Anoxic Sediments (Anoxic Sediment Bacteria Interactions)

Contributors	Affiliation	Role
Malkin, Sairah	University of Maryland Center for Environmental Science (UMCES/HPL)	Principal Investigator
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Abstract
These data were collected as part of a sediment incubation experiment, to investigate potential interactions between estuarine cable bacteria and their associated microbial community. Sediments were collected from the main channel of Chesapeake Bay at a mesohaline station that experiences seasonal oxygen depletion. The upper 10 centimeters (cm) of sediment was homogenized under anaerobic conditions, packed into polycarbonate core liners, and incubated in a dark climate-controlled room in aerated aquaria with artificial seawater (S=15.5; T=16 degrees Celsius). In a sub-set of core tubes, a 0.2 micron polycarbonate filter was held embedded at 0.5 cm depth, to block the downward growth of cable bacteria while allowing for porewater diffusion. The sediments (with and without embedded filters) were destructively sampled on 6 dates over 46 days, at which time nucleic acids, samples for microscopy, and samples for porewater geochemistry were collected. Microsensor profiling (oxygen (O2), pH, hydrogen sulfide (H2S)) was conducted alongside the destructive sampling. Associated nucleic acid data are available through NCBI Sequence Read Archive, under Bioproject PRJNA833464. Sediment porewaters were handled anaerobically, and were extracted by centrifugation followed by filtration (0.2 micron in-line filters). Geochemical data include porewater anions (sulfate and chloride) measured by ion chromatography, and ammonium and ferrous iron concentrations measured by standard colorimetric methods. Microscopy data include both counts of cable bacteria measured with FISH oligoprobe DSB706, and total single cell bacteria. The dataset was generated by Pinky Liau under the supervision of Dr. Sairah Malkin, Horn Point Laboratory, U. Maryland Center for Environmental Sciences.

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Coverage

Spatial Extent: **Lat**:38.55505 **Lon**:-76.42794
Temporal Extent: 2018-12 - 2019-01

Methods & Sampling

The source material was collected from Chesapeake Bay (38.55505 N, 76.42794 W) (mesohaline), water column depth 26 meters, sediment horizon 0-10 centimeter below sea floor.

Incubation conditions: 16 degrees Celsius, S=15.5, dark, aerated.

Incubation Set-up: Sediments were homogenized and packed into polycarbonate core liners, sealed with a stopper at the bottom, and open to aerated aquarium water at the top. In a subset of cores, a polycarbonate filter (pore size 0.2 microns) was secured at 0.5 cm depth, to prevent downward growth of cable bacteria in these treatments. Sediments were incubated for up to 46 days. At 6 time points, microsensor profiles were measured, followed by destructive sampling.

Porewater extraction: Sediments were sectioned at 0.5 cm depth increments in an anaerobic glove bag under nitrogen atmosphere. Porewaters were separated by centrifugation (3500 rpm for 10 minutes), and filtered (0.2 micron) and aliquoted in the anaerobic glove bag. Samples for ferrous iron measurements were preserved with trace-metal grade nitric acid (final pH < 2).

Microsensor Profiling: High-resolution microsensor profiling of oxygen (O2), pH, and hydrogen sulfide (H2S) was performed on replicate sediment cores with 1 profile made per sediment core per analyte, using commercial microsensors operated with a motorized micromanipulator (Unisense A.S., Denmark). Oxygen sensor data were calibrated with a 2-point calibration using air-saturated water and anoxic zone of sediments. pH sensors were calibrated with a 3-point NBS buffer calibration. Sulfide (SumH2S) was calibrated with 5-point calibration using NaS2 (0-300 micromolar), and corrected with pH at the corresponding depth. Detailed methodology is given in Malkin et al. 2014.

Data Processing Description

BCO-DMO Processing:
- replaced "NA" with "nd" (no data value).

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Data Files

File	
microsensor_profiling_o2.csv	(Comma Separated Values (.csv), 66.39 KB) MD5:9ac7491b0f61e21bd4dead4cf35d2ee5
Primary data file for dataset ID 883412	

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Related Publications

Liau, P., Kim, C., Saxton, M. A., & Malkin, S. Y. (2022). Microbial succession in a marine sediment: Inferring interspecific microbial interactions with marine cable bacteria. Environmental Microbiology. Portico. https://doi.org/10.1111/1462-2920.16230
Results

Malkin, S. Y., Rao, A. M., Seitaj, D., Vasquez-Cardenas, D., Zetsche, E.-M., Hidalgo-Martinez, S., … Meysman, F. J. (2014). Natural occurrence of microbial sulphur oxidation by long-range electron transport in the seafloor. The ISME Journal, 8(9), 1843–1854. doi:10.1038/ismej.2014.41
Methods

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Related Datasets

IsRelatedTo

Malkin, S. (2022) **Geochemistry and microscopy from incubation experiments of Chesapeake Bay sediments conducted at Horn Point Laboratory.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-11-02 doi:10.26008/1912/bco-dmo.883171.1 [view at BCO-DMO]

Malkin, S. (2022) **H2S microsensor profiling conducted alongside the destructive sampling of Chesapeake Bay sediments during incubation experiments at Horn Point Lab.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-11-09 doi:10.26008/1912/bco-dmo.883506.1 [view at BCO-DMO]

Malkin, S. (2022) **pH microsensor profiling conducted alongside the destructive sampling of Chesapeake Bay sediments during incubation experiments at Horn Point Lab.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-11-09 doi:10.26008/1912/bco-dmo.883488.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
SampleID	A unique code for each sample	unitless
Treatment	The treatment of the sediments; values are “NoFilter” or “Filter”, as described in methods	unitless
CoreRep	A replicate code for which sediment core was examined	unitless
Day	Time of sampling after cores were homogenized and incubated in days	days
Depth_mm	The depth of the measurements	millimeters (mm)
O2_mM	Dissolved oxygen concentration	micromolar (mM)
Comment	Additional relevant information, e.g., whether measurements were 'above' or 'below' the embedded filter	unitless

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Instruments

Dataset-specific Instrument Name	Unisense sensors
Generic Instrument Name	Unisense oxygen microsensor
Dataset-specific Description	Unisense sensors and micromanipulator
Generic Instrument Description	The Unisence oxygen microsensor is a miniaturized Clark-type dissolved oxygen instrument, including glass micro-sensors with minute tips (diameters ranging from 1 to 800 um). A gold sensing cathode is polarized against an internal reference and, driven by external partial pressure, oxygen from the environment penetrates through the sensor tip membrane and is reduced at the sensing cathode surface. A picoammeter converts the resulting reduction current to a signal. The sensor also includes a polarized guard cathode, which scavenges oxygen in the electrolyte, thus minimizing zero-current and pre-polarization time. See more on the manufacturer's website: https://www.unisense.com/

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Project Information

Collaborative Research: Probing the Metabolic and Electrical Interactions of Cable Bacteria in Anoxic Sediments (Anoxic Sediment Bacteria Interactions)

Coverage: Chesapeake Bay sediments; Mid-Atlantic Coastal sediments

NSF Award Abstract:
Marine sediments represent the world's largest repository of stored organic carbon, and understanding how microorganisms break down this carbon is an imperative for understanding global carbon cycling. Yet long-standing questions remain regarding how networks of microorganisms work together to accomplish the complete breakdown of organic carbon in marine sediments. Sediment microbes interact in a myriad of ways that couple their metabolism to the break down of organic carbon, including by sharing products of metabolism. Accumulating evidence further suggests that some microorganisms can interact by transferring electrons directly to other unrelated microorganisms. This ability occurs across diverse microorganisms and appears to be widespread in the biosphere, particularly in anaerobic environments such as marine sediments. This project addresses emerging questions about the identity and metabolic linkages between microorganisms that work together in natural anaerobic marine and estuarine sediments to break down organic carbon. The investigators approach these questions by focusing on the influence of a keystone bacterium on its surrounding microbial community. "Cable bacteria" are a recently discovered group of long filamentous bacteria that act as electrical conductors in aquatic sediments providing a conduit for electrons to commute from deeper sulfidic sediments up to the surface oxygen layer by the process of centimeter-scale electron transport. Since their discovery about 6 years ago, these bacteria have been observed in a wide range of depositional sedimentary environments, often at extremely high cell densities. Where these bacteria are abundant, such as in coastal marine muds, they drive intense localized changes in pH and strongly influence the mineral cycling. This research explores the direct and indirect influence of cable bacteria on the metabolic activity of associated microorganisms. This project also advance the education and training of two early-career investigators, two PhD students, and undergraduate students. The skills and expertise gained from these PhD research projects will enable the students to be competitive in academic pursuits and in bioinformatics and technology applications relevant to private industry. The scientific discoveries emerging from this work is being incorporated into undergraduate and graduate level courses in marine microbial ecology. The research team will reach out to the broader community by hosting public lectures promoting a better understanding of environmental microbial ecology.

The proposed work is to investigate the role of cable bacteria in structuring sediment microbial communities. Due to their growth strategy and morphology, cable bacteria are particularly amenable to experimental

manipulation, providing an outstanding opportunity to better understand community interactions among microorganisms in a natural and complex anaerobic environment. The investigators will explore the interactions and relationships between cable bacteria and their associated microbial community by manipulating the growth and activity of cable bacteria and quantifying the resultant microbial community response. Specifically, this project aims to (1) identify microorganisms whose growth is enhanced by cable bacteria, (2) identify metabolic processes linked with cable bacteria activity using metatranscriptomics, (3) test specific metabolic links between sediment microorganisms and cable bacteria activity using a DNA-stable isotope probing (SIP) approach, and (4) visually confirm the identity and quantify key microorganisms associated with cable bacteria using microscopy. As more is learned about the identity and the mechanisms by which microorganisms are metabolically linked in anoxic sediments, we will be better able to understand and make predictions about how microorganisms function in their environment and how they can be utilized in bioengineered systems.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756877
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756851

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