Oxygen consumption rates/zero valen iron dissolution of FeOB (Ferrozine assay) with Kanamycin addition

Website: https://www.bco-dmo.org/dataset/709543
Data Type: experimental
Version: 1
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Project
» Collaborative Research: The Role of Iron-oxidizing Bacteria in the Sedimentary Iron Cycle: Ecological, Physiological and Biogeochemical Implications (SedimentaryIronCycle)

Program
» Center for Dark Energy Biosphere Investigations (C-DEBI)

Contributors	Affiliation	Role
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Abstract
Oxygen consumption rates/zero valen iron dissolution of FeOB (Ferrozine assay) with Kanamycin addition

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Coverage

Temporal Extent: 2016-11-05 - 2016-11-08

Dataset Description

In these experiments, oxygen consumption rates were measured for the iron-oxidizing bacteria (FeOB) Mariprofundus ferrooxydans PV-1 as well as the neutrophilic FeOB "TAG-1" (An isolate from hydrothermal vents in the Mid Atlantic ridge that has not yet been formally named. TAG simply refers to the TAG hydrothermal site from which this microbe was isolated.). These experiments measure oxygen consumption at 100 uM oxygen at 20 degrees C. After 3 days the media in each vessel was replaced with fresh media containing kanamycin to stop any further growth and examine abiotic effects of iron mat production on zero valent iron dissolution.

Methods & Sampling

These data were collected by placing each strain in a 100 mL serum vial with 6 mL of their standard, published

media with 30 mg zero valent iron as a source of Fe(II). The headspace was filled with a gas mix of 8% oxygen/10% carbon dioxide/82% nitrogen by using bottled gas mixes and a regulator to flush the headspace without over pressurization. Prior to sealing the serum vials, a Presens OPTODE dot (sensor) was placed inside the vial, allowing non-invasive gas sampling of the changes in O2 in the headspace. A Presens four channel system was used to measure changes in oxygen concentration in real-time in each bottle. A total of four channels were measured during each experiment: channels 1 through 3 are the biological treatments and channel 4 was a kill control (microbes were by placing on a heat block at 100 degrees C for 5 minutes). After 3 days of incubation, the concentration of Fe(II) in the media was measured by ferrozine assay. Old media was then removed and replaced with fresh media containing 30 ng/ml kanamycin to prevent growth of remaining cells. The headspace was again filled with the same gas mix and oxygen concentrations were measured in real-time in each vial. Fe(II) concentration was determined daily by ferrozine assay for 3 more days.

Data Processing Description

Data was acquired using PreSens Measurement Studio 2 RC4 v0.5.6039.20506

Oxygen concentration readings cut out for PV-1 after approximately 4 days - will be fixed in future experiment.

BCO-DMO Data Processing Notes:
-Reformatted column names to comply with BCO-DMO standards
-Reformatted dates from mm/dd/yy to yyyy/mm/dd
-Replaced spaces with underscores
-Replaced N/A with nd

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Data Files

File
ferrozine_vial.csv (Comma Separated Values (.csv), 2.54 KB) MD5:cf976e3fd9051ec4e9edd40c4463261f Primary data file for dataset ID 709543

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Parameters

Parameter	Description	Units
vial	[strain] ASWkan ferrozine sample description	unitless
date	Date measurement was taken; YYYY/MM/DD	unitless
treatment	Whether measurement was of starting media (ASW) or replacement media (ASW + Kan)	unitless
time_elapsed	Time since start of experiment	hours
Fe_II_concentration	Concentration of Fe(II) in media (average of triplicate samples)	mM
standard_deviation	Standard deviation of triplicate samples	mM

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Instruments

Dataset-specific Instrument Name	PreSens OXY-4 SMA four channel optode and PreSens Pst3 optode sensor spots
Generic Instrument Name	Optode
Dataset-specific Description	Used with air saturated water and 100% nitrogen gas.
Generic Instrument Description	An optode or optrode is an optical sensor device that optically measures a specific substance usually with the aid of a chemical transducer.

Dataset-specific Instrument Name	Cary 100 UV-Vis Spectrophotometer (Agilent Technologies)
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	Used to measure ferrozine assay
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

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Project Information

Collaborative Research: The Role of Iron-oxidizing Bacteria in the Sedimentary Iron Cycle: Ecological, Physiological and Biogeochemical Implications (SedimentaryIronCycle)

Coverage: Intertidal coastal river and coastal shelf sediments, mid-coast, Maine, USA; Monteray Bay Canyon, sediments, CA, USA

Iron is a critical element for life that serves as an essential trace element for eukaryotic organisms. It is also able to support the growth of a cohort of microbes that can either gain energy for growth via oxidation of ferrous (Fe(II)) to ferric (Fe(III)) iron, or by utilizing Fe(III) for anaerobic respiration coupled to oxidation of simple organic matter or H2. This coupled process is referred to as the microbial iron cycle. One of the primary sources of iron to the ocean comes from dissolved iron (dFe) that is produced through oxidation and reduction processes in the sediment where iron is abundant. The dFe is transported into the overlaying water where it is an essential nutrient for phytoplankton responsible for primary production in the world's oceans. In fact, iron limitation significantly impacts production in as much as a third of the world's open oceans. The basic geochemistry of this process is understood; however important gaps exist in our knowledge about the details of how the iron cycle works, and how critical a role bacteria play in it.

Intellectual Merit. Conventional wisdom holds that most of the iron oxidation in sediments is abiological, as a result of the rapid kinetics of chemical iron oxidation in the presence of oxygen. This proposal aims to question this conventional view and enhance our understanding of the microbes involved in the sedimentary iron cycle, with an emphasis on the bacteria that catalyze the oxidation of iron. These Fe-oxidizing bacteria (FeOB) utilize iron as a sole energy source for growth, and are autotrophic. They were only discovered in the ocean about forty-five years ago, and are now known to be abundant at hydrothermal vents that emanate ferrous-rich fluids. More recently, the first evidence was published that they could inhabit coastal sediments, albeit at reduced numbers, and even be abundant in some continental shelf sediments. These habitats are far removed from hydrothermal vents, and reveal the sediments may be an important habitat for FeOB that live on ferrous iron generated in the sediment. This begs the question: are FeOB playing an important role in the oxidative part of the sedimentary Fe-cycle? One important attribute of FeOB is their ability to grow at very low levels of O2, an essential strategy for them to outcompete chemical iron oxidation. How low a level of O2 can sustain them, and how this might affect their distribution in sediments is unknown. In part, this is due to the technical challenges of measuring O2 concentrations and dynamics at very low levels; yet these concentrations

could be where FeOB flourish. The central hypothesis of this proposal is that FeOB are more common in marine sedimentary environments than previously recognized, and play a substantive role in governing the iron flux from the sediments into the water column by constraining the release of dFe from sediments. A set of experimental objectives are proposed to test this. A survey of near shore regions in the Gulf of Maine, and a transect along the Monterey Canyon off the coast of California will obtain cores of sedimentary muds and look at the vertical distribution of FeOB and putative Fe-reducing bacteria using sensitive techniques to detect their presence and relative abundance. Some of these same sediments will be used in a novel reactor system that will allow for precise control of O2 levels and iron concentration to measure the dynamics of the iron cycle under different oxygen regimens. Finally pure cultures of FeOB with different O2 affinities will be tested in a bioreactor coupled to a highly sensitive mass spectrometer to determine the lower limits of O2 utilization for different FeOB growing on iron, thus providing mechanistic insight into their activity and distribution in low oxygen environments.

Broader Impacts. An important impact of climate change on marine environments is a predicted increase in low O2 or hypoxic zones in the ocean. Hypoxia in association with marine sediments will have a profound influence on the sedimentary iron cycle, and is likely to lead to greater inputs of dFe into the ocean. In the longer term, this increase in dFe flux could alleviate iron-limitation in some regions of the ocean, thereby enhancing the rate of CO2-fixation and draw down of CO2 from the atmosphere. This is one important reason for developing a better understanding of microbial control of sedimentary iron cycle. This project will also provide training to a postdoctoral scientist, graduate students and undergraduates. This project will contribute to a student initiated exhibit, entitled 'Iron and the evolution of life on Earth' at the Harvard Museum of Natural History providing a unique opportunity for undergraduate training and outreach.

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Program Information

Center for Dark Energy Biosphere Investigations (C-DEBI)

Website: http://www.darkenergybiosphere.org

Coverage: Global

The mission of the Center for Dark Energy Biosphere Investigations (C-DEBI) is to explore life beneath the seafloor and make transformative discoveries that advance science, benefit society, and inspire people of all ages and origins.

C-DEBI provides a framework for a large, multi-disciplinary group of scientists to pursue fundamental questions about life deep in the sub-surface environment of Earth. The fundamental science questions of C-DEBI involve exploration and discovery, uncovering the processes that constrain the sub-surface biosphere below the oceans, and implications to the Earth system. What type of life exists in this deep biosphere, how much, and how is it distributed and dispersed? What are the physical-chemical conditions that promote or limit life? What are the important oxidation-reduction processes and are they unique or important to humankind? How does this biosphere influence global energy and material cycles, particularly the carbon cycle? Finally, can we discern how such life evolved in geological settings beneath the ocean floor, and how this might relate to ideas about the origin of life on our planet?

C-DEBI's scientific goals are pursued with a combination of approaches:
(1) coordinate, integrate, support, and extend the research associated with four major programs—Juan de Fuca Ridge flank (JdF), South Pacific Gyre (SPG), North Pond (NP), and Dorado Outcrop (DO)—and other field sites;
(2) make substantial investments of resources to support field, laboratory, analytical, and modeling studies of the deep subseafloor ecosystems;
(3) facilitate and encourage synthesis and thematic understanding of submarine microbiological processes, through funding of scientific and technical activities, coordination and hosting of meetings and workshops, and support of (mostly junior) researchers and graduate students; and
(4) entrain, educate, inspire, and mentor an interdisciplinary community of researchers and educators, with an emphasis on undergraduate and graduate students and early-career scientists.

Note: Katrina Edwards was a former PI of C-DEBI; James Cowen is a former co-PI.

Data Management:
C-DEBI is committed to ensuring all the data generated are publically available and deposited in a data repository for long-term storage as stated in their Data Management Plan (PDF) and in compliance with the NSF Ocean Sciences Sample and Data Policy. The data types and products resulting from C-DEBI-supported research include a wide variety of geophysical, geological, geochemical, and biological information, in addition to education and outreach materials, technical documents, and samples. All data and information generated by C-DEBI-supported research projects are required to be made publically available either following publication of research results or within two (2) years of data generation.

To ensure preservation and dissemination of the diverse data-types generated, C-DEBI researchers are working with BCO-DMO Data Managers make data publicly available online. The partnership with BCO-DMO helps ensure that the C-DEBI data are discoverable and available for reuse. Some C-DEBI data is better served by specialized repositories (NCBI's GenBank for sequence data, for example) and, in those cases, BCO-DMO provides dataset documentation (metadata) that includes links to those external repositories.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1459252

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