Pore water and solid phase iron geochemical data from a coastal Maine intertidal mudflat from November 2015 to November 2016

Website: https://www.bco-dmo.org/dataset/737962
Data Type: Other Field Results
Version: 1
Version Date: 2018-06-01

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
Emerson, David	Bigelow Laboratory for Ocean Sciences	Principal Investigator
Girguis, Peter	Harvard University	Co-Principal Investigator
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Abstract
Pore water and solid phase iron geochemical data from a coastal Maine intertidal mudflat from November 2015 to November 2016.

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Coverage

Spatial Extent: **Lat**:43.994827 **Lon**:-69.648632
Temporal Extent: 2015-11-18 - 2016-11-09

Methods & Sampling

Sediment cores were retrieved from bioturbated, intertidal sediments at low tide with a 7.5 cm (inner diameter) clear Plexiglas liner by pushing it directly into the sediment with minimum pressure as not to artificially force the sediment horizons together. The end of the core (i.e., the deepest horizon) was plugged with a rubber stopper and the sediment core was placed on ice. Typical transport back to the laboratory for pore water extraction was 0.5 hours. Sediment temperature and bottom water salinity were recorded at the time of sampling with an alcohol thermometer and refractometer, respectively.

Once back to the laboratory, the cores were removed from ice and 5 cm Rhizons (0.16-0.19 um pore size) were inserted into pre-drilled 7 mm holes at 1 cm depth intervals to a depth of 10 cm. Pore waters were extracted by pulling negative pressure on the Rhizon with a 10 mL sterile syringe and holding the syringe plunger in place with a small wooden block placed between the syringe body and the plunger. Once pore water was extracted in the syringe, it was removed from the Rhizon, dispensed into a 15 mL centrifuge tube, and 250 uL of pore water was immediately transferred to 250 uL of Ferrozine buffer (10 mM in 50 mM HEPES buffer) and read on a MultiSkan MCC plate reader at 562 nm absorbance. The sediment core was then extruded and sliced into 1 cm intervals and dried in an oven at 70-80 degrees C for 24 hours, and then poorly-crystalline iron oxides (i.e., ferrihydrite and lepidocrocite) were extracted with 1 M hydroxylamine HCl in 25 % acetic acid (v/v) for 48 hours on a rotating shaker at 200 rpm. The extractions were allowed to settle for a few hours, then 10 uL was diluted into 990 uL (1:100 dilution) of distilled water containing 100 uL of Ferrozine buffer. The samples were read as above at 562 nm on the Multiskan MCC plate reader.

Note: data were not collected for months of August and October .

Data Processing Description

BCO-DMO Processing:
- separated lat and long into different columns;
- modified parameter names to conform with BCO-DMO naming conventions;
- changed date format to yyyymmdd.

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Data Files

File	
seasonal_Fe_biogeochem.csv	(Comma Separated Values (.csv), 5.69 KB) MD5:209d4825187340c946a829f2a954b73f
Primary data file for dataset ID 737962	

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Related Publications

Beam, J. P., Scott, J. J., McAllister, S. M., Chan, C. S., McManus, J., Meysman, F. J. R., & Emerson, D. (2018). Biological rejuvenation of iron oxides in bioturbated marine sediments. The ISME Journal, 12(5), 1389–1394. doi:10.1038/s41396-017-0032-6
General
,
General

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Parameters

Parameter	Description	Units
site	Name of sampling site	unitless
lat	Latitude of sampling site	decimal degrees
long	Longitude of sampling site	decimal degrees
date	Date of sampling; formatted as yyyymmdd	unitless
depth	Sampling depth	centimeters (cm)
sed_temp	Sediment temperature	degrees Celsius
salinity	Low tide surface water salinity	practical salinity units
ferrous_iron	Dissolved pore water ferrous iron	micromoles per liter (umol/L)
poorly_crystalline_iron_oxide	Sedimentary poorly-crystalline iron oxide Fe	micromoles per gram dry sediment (umol/g)

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Instruments

Dataset-specific Instrument Name	MultiSkan MCC plate reader
Generic Instrument Name	plate reader
Generic Instrument Description	Plate readers (also known as microplate readers) are laboratory instruments designed to detect biological, chemical or physical events of samples in microtiter plates. They are widely used in research, drug discovery, bioassay validation, quality control and manufacturing processes in the pharmaceutical and biotechnological industry and academic organizations. Sample reactions can be assayed in 6-1536 well format microtiter plates. The most common microplate format used in academic research laboratories or clinical diagnostic laboratories is 96-well (8 by 12 matrix) with a typical reaction volume between 100 and 200 uL per well. Higher density microplates (384- or 1536-well microplates) are typically used for screening applications, when throughput (number of samples per day processed) and assay cost per sample become critical parameters, with a typical assay volume between 5 and 50 µL per well. Common detection modes for microplate assays are absorbance, fluorescence intensity, luminescence, time-resolved fluorescence, and fluorescence polarization. From: http://en.wikipedia.org/wiki/Plate_reader, 2014-09-0-23.

Dataset-specific Instrument Name	
Generic Instrument Name	Push Corer
Generic Instrument Description	Capable of being performed in numerous environments, push coring is just as it sounds. Push coring is simply pushing the core barrel (often an aluminum or polycarbonate tube) into the sediment by hand. A push core is useful in that it causes very little disturbance to the more delicate upper layers of a sub-aqueous sediment. Description obtained from: http://web.whoi.edu/coastal-group/about/how-we-work/field-methods/coring/

Dataset-specific Instrument Name	Handheld salinity refractometer with temperature compensation (Marine Depot)
Generic Instrument Name	Refractometer
Generic Instrument Description	A refractometer is a laboratory or field device for the measurement of an index of refraction (refractometry). The index of refraction is calculated from Snell's law and can be calculated from the composition of the material using the Gladstone-Dale relation. In optics the refractive index (or index of refraction) n of a substance (optical medium) is a dimensionless number that describes how light, or any other radiation, propagates through that medium.

Dataset-specific Instrument Name	
Generic Instrument Name	Thermometer
Generic Instrument Description	A device designed to measure temperature.

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Deployments

2015-16_Sampling_Emerson

Website	https://www.bco-dmo.org/deployment/737990
Platform	The Eddy
Start Date	2016-01-15
End Date	2016-11-09
Description	Sampling conducted at an intertidal mudflat, "The Eddy", from coastal Maine (43.994827, -69.648632)

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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-1459600
NSF Division of Ocean Sciences (NSF OCE)	OCE-1459252

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