Methane and sulfate concentration profiles - sediment cores from White Oak River estuary in October 2012 (IODP-347 Microbial Quantification project)

Website: https://www.bco-dmo.org/dataset/649751
Data Type: Other Field Results
Version:
Version Date: 2016-06-22

Project
» Quantifying the contribution of the deep biosphere in the marine sediment carbon cycle using deep-sea sediment cores from the Baltic Sea (IODP-347 Microbial Quantification)

Programs
» Center for Dark Energy Biosphere Investigations (C-DEBI)
» International Ocean Discovery Program (IODP)

Contributors	Affiliation	Role
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Coverage

Temporal Extent: 2012-10-01

Dataset Description

This dataset resulted from a graduate student project called "Culture independent genomic comparisons reveal environmental adaptations for Altiarchaeales". The data is associated with a manuscript submitted to Frontier in Microbiology. The samples are from the White Oak River estuary, North Carolina, Station H to a sediment depth of 75 cm. The project was partially funded by OCE grants.

Related reference: Environmental evidence for net methane production and oxidation in putative ANaerobic MEthanotrophic (ANME) archaea (2011) by Karen G. Lloyd, Marc J. Alperin, Andreas Teske. Contains detailed methods that were nearly identical to the methods used here and similar data from the same location.

Methods & Sampling

The cores were sequentially cut into 3 cm section from the topmost to bottommost depth. For methane

measurements, 3 ml of sediments were taken via cut-off syringe immediately after each section was sliced and quickly added to 60 ml serum vials containing 1 ml of 0.1 M KOH, which were stoppered and crimp-sealed with butyl rubber stoppers to minimize gas loss. After being shaken for 1 min to release methane from sediments (> 99.5% of the methane equilibrated in the headspace), a 5 ml headspace aliquot was displaced with an equal volume of anaerobic distilled water, injected into a 1 ml sample loop, and then analyzed on an Agilent 7890a gas chromatograph equipped with flame ionization detector. For sulfate measurements, plastic 15 ml tubes filled completely with sediment were centrifuged and the resulting porewater was filtered at 0.2 μm, acidified with 10% HCl and measured using a 2010i Dionex ion chromatograph.

Data Processing Description

Methane concentrations (mmol per litre of porewater) were calculated using the following equation:
$[CH_4] = (\rho(CH_4)V_{headspace})/(RT\varphi V_{sed}1000)$
where p(CH4) is the partial pressure of methane (in ppmv), Vheadspace is the volume of the serum vial headspace (ml) after the sediment and KOH are added, R is the universal gas constant, T is the temperature at time of measurement in Kelvin and Vsed is the volume (ml) of whole sediment added to the serum vial.

Porosity, φ, was calculated using the formula:
$\varphi = (m_w/\rho_w)/(m_w/\rho_w+((m_d-S*m_w/1000)/\rho_{ds}))$
where m_w is the mass of the water lost on drying, m_d is the mass of the dried sediment, ρ_w is the density of pure water, ρ_{ds} is the density of dry sediment (assumed to be 2.5 g cm−3), and S is salinity in grams per kilogram (assumed to be 19 grams per kilogram for all samples).

Standards at sulfate concentrations 0, 0.1, 0.5, 1, 5, 10 mM measure prior to samples from each core and sample peak areas were converted to sulfate concentrations using the standard curves after accounting for the dilution ((peak area * slope + intercept) * 0.7 / 0.6) by the 10% HCl.

No samples have been flagged as below the detection limit.

BCO-DMO Processing:

- added conventional header with dataset name, PI name, version date
- renamed parameters to BCO-DMO and BODC standards
- replaced NaN with nd
- removed CH4_mod data

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Data Files

File
meth_sulf.csv(Comma Separated Values (.csv), 2.80 KB) MD5:3b98585f72f6f37aaf268b8a2bcb9b4d
Primary data file for dataset ID 649751

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Parameters

Parameter	Description	Units
site	site identification	unitless
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
depth	depth of core sample	meters
CH4	methane concentration in porewater	mM
SO4	sulfate concentration in porewater	mM
core	core identification	unitless
CH4_mod	???methane concentration in porewater - modified in some way???	mM
porosity	measure of the void (i.e. "empty") spaces in wet sediment volume that evaporated after few weeks at 80ºC (i.e the water) in VV/VT	unitless

Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Gas Chromatograph
Dataset-specific Description	Agilent 7890a gas chromatograph equipped with flame ionization detector
Generic Instrument Description	Instrument separating gases, volatile substances, or substances dissolved in a volatile solvent by transporting an inert gas through a column packed with a sorbent to a detector for assay. (from SeaDataNet, BODC)

Dataset-specific Instrument Name	
Generic Instrument Name	Ion Chromatograph
Dataset-specific Description	2010i Dionex ion chromatograph
Generic Instrument Description	Ion chromatography is a form of liquid chromatography that measures concentrations of ionic species by separating them based on their interaction with a resin. Ionic species separate differently depending on species type and size. Ion chromatographs are able to measure concentrations of major anions, such as fluoride, chloride, nitrate, nitrite, and sulfate, as well as major cations such as lithium, sodium, ammonium, potassium, calcium, and magnesium in the parts-per-billion (ppb) range. (from http://serc.carleton.edu/microbelife/research_methods/biogeochemical/ic....)

Deployments

White_Oak_River

Website	https://www.bco-dmo.org/deployment/649762
Platform	Unknown Vessel
Start Date	2012-10-01
End Date	2012-10-31

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Project Information

Quantifying the contribution of the deep biosphere in the marine sediment carbon cycle using deep-sea sediment cores from the Baltic Sea (IODP-347 Microbial Quantification)

Coverage: Baltic Sea

Marine sediments contain a microbial population large enough to rival that of Earth's oceans, but much about this vast community is unknown. Innovations in total cell counting methods have refined estimates of cell concentrations, but tell us nothing about specific taxa. Isotopic data provides evidence that a majority of subsurface microorganisms survive by breaking down organic matter, yet measurable links between specific microbial taxa and their organic matter substrates are untested. The proposed work overcomes these limitations, with a particular focus on the degradation of proteins and carbohydrates, which comprise the bulk of classifiable sedimentary organic matter. The project will link specific taxa to potential extracellular enzyme activity in the genomes of single microbial cells, apply newly-identified, optimal methods for counting viable cells belonging to specific taxa using catalyzed reporter deposition fluorescent in situ hybridization (CARD-FISH), and measure the potential activity of their enzymes in situ. The resulting data will provide key evidence about the strategies subsurface life uses to overcome extreme energy limitation and contribute to the long-term carbon cycle.

The Principal Investigators are employing novel,improved methods to quantify cells of specific taxa in the marine subsurface and to determine the biogeochemical functions of those uncultured taxa, including:
1) Determine the pathway of organic carbon degradation in single cell genomes of uncultured, numerically dominant subsurface microorganisms.
2) Quantify viable bacteria and archaea in the deep subsurface using an improvement on the existing technology of CARD-FISH.
3)Measure the potential activities (Vmax values) of enzymes in deep Baltic Sea sediments, and use the abundances of enzyme-producing microorganisms to calculate depth profiles of cell-specific Vmax values.

The project combines these methods in order to identify and quantify the cells capable of degrading organic matter in deep sediments of the Baltic Sea, obtained from Integrated Ocean Drilling Program (IODP) expedition 347. These results will greatly expand our knowledge of the function and activity of uncultured microorganisms in the deep subsurface.

This project is associated with C-DEBI account number 157595.

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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.

International Ocean Discovery Program (IODP)

Website: http://www.iodp.org/index.php

Coverage: Global

The International Ocean Discovery Program (IODP) is an international marine research collaboration that explores Earth's history and dynamics using ocean-going research platforms to recover data recorded in seafloor sediments and rocks and to monitor subseafloor environments. IODP depends on facilities funded by three platform providers with financial contributions from five additional partner agencies. Together, these entities represent 26 nations whose scientists are selected to staff IODP research expeditions conducted throughout the world's oceans.

IODP expeditions are developed from hypothesis-driven science proposals aligned with the program's science plan *Illuminating Earth's Past, Present, and Future*. The science plan identifies 14 challenge questions in the four areas of climate change, deep life, planetary dynamics, and geohazards.

IODP's three platform providers include:

- The U.S. National Science Foundation (NSF)
- Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT)
- The European Consortium for Ocean Research Drilling (ECORD)

More information on IODP, including the Science Plan and Policies/Procedures, can be found on their website at http://www.iodp.org/program-documents.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1431598

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