Porewater measurements of nitrate concentration and N and O isotopic ratios (d15N and d18O) from bore holes at North Pond; collected during IODP expedition 336 on R/V JOIDES Resolution in the Mid-Atlantic Ridge in 2011

Website: https://www.bco-dmo.org/dataset/637919
Data Type: Cruise Results
Version: 04 Feb 2016
Version Date: 2016-02-04

Project
» IODP Expedition 336- Mid-Atlantic Ridge Microbiology (Mid-Atl Ridge Microbio)

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

Contributors	Affiliation	Role
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Dataset Description

Dataset includes porewater measurements of nitrate concentration and N and O isotopic ratios (d15N and d18O) from bore holes U1382B, U1383D, and U1384A at North Pond during IODP 336.

Methods & Sampling

Sediment cores were collected using an advanced piston corer. Porewaters were extracted by Rhizon samplers either immediately shipboard or later on 10cm whole core rounds that were stored at -80 degrees C.

Nitrate from shipboard extracted samples were measured using ion chromatography, where samples collected later were measured using chemiluminescence after reduction in hot acidic vanadyl sulfate solution on a NOx analyzer (Braman and Hendrix, 1989) (detection limit <0.5 uM). Nitrite was measured using the Griess-Ilosvay method followed by measuring absorption at 540 nm or by chemiluminescence in a sodium iodide solution on a NOx analyzer.

Stable isotopes of nitrate were measured using the denitrifier method (Casciotti et al., 2002; Sigman et al., 2001). Where detected, nitrite was removed by sulfamic acid addition (Granger and Sigman, 2009) prior to isotopic analysis of the nitrate. Samples were run on either a Delta V Advantage (Thermo, Inc.) at the University of Basel or an IsoPrime100 (Elementar, Inc.)

Data Processing Description

For the stable isotope measurements, corrections for drift, size and fractionation of isotopes during the denitrifier method were carried out using nitrate standards USGS 32, USGS 34, and USGS 35 (Casciotti et al., 2002; McIlvin and Casciotti, 2011), with a typical reproducibility of 0.2 and 0.4 ‰ for δ15N and δ18O, respectively.

BCO-DMO Processing:
- modified parameter names to conform with BCO-DMO naming conventions;
- added cruise ID;
- replaced blanks (missing data) with "nd", meaning "no data".

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Data Files

File
NPNitrateNO.csv (Comma Separated Values (.csv), 7.27 KB) MD5:da4c28eb568d87f1946a6ee6e7616242 Primary data file for dataset ID 637919

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Parameters

Parameter	Description	Units
core	Core identifier.	dimensionless
lat	Latitude.	decimal degrees
lon	Longitude.	decimal degrees
bottom_water_depth	Bottom water depth.	meters (m)
cruise_id	Cruise identifier.	dimensionless
sample	Sample identifier.	dimensionless
section	Section identifier.	dimensionless
depth_mbsf	Depth (top of section mbsf).	meters below sea floor (mbsf)
nitrate	Nitrate.	?
nitrite	Nitrite.	?
d15N_nitrate	d15N-Nitrate.	?
d18O_nitrate	d18O-Nitrate.	?

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Instruments

Dataset-specific Instrument Name	Advanced Piston Corer
Generic Instrument Name	Advanced Piston Corer
Dataset-specific Description	Sediment cores were collected using an advanced piston corer.
Generic Instrument Description	The JOIDES Resolution's Advanced Piston Corer (APC) is used in soft ooze and sediments. The APC is a hydraulically actuated piston corer designed to recover relatively undisturbed samples from very soft to firm sediments. More information is available from IODP (PDF).

Dataset-specific Instrument Name	NOx analyzer
Generic Instrument Name	Chemiluminescence NOx Analyzer
Dataset-specific Description	Nitrate from shipboard extracted samples were measured using ion chromatography, where samples collected later were measured using chemiluminescence after reduction in hot acidic vanadyl sulfate solution on a NOx analyzer (Braman and Hendrix, 1989) (detection limit
Generic Instrument Description	The chemiluminescence method for gas analysis of oxides of nitrogen relies on the measurement of light produced by the gas-phase titration of nitric oxide and ozone. A chemiluminescence analyzer can measure the concentration of NO/NO2/NOX. One example is the Teledyne Model T200: https://www.teledyne-api.com/products/nitrogen-compound-instruments/t200

Dataset-specific Instrument Name	Ion Chromatography
Generic Instrument Name	Ion Chromatograph
Dataset-specific Description	Nitrate from shipboard extracted samples were measured using ion chromatography.
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....)

Dataset-specific Instrument Name	Delta V Advantage or IsoPrime100
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	Samples were run on either a Delta V Advantage (Thermo, Inc.) at the University of Basel or an IsoPrime100 (Elementar, Inc.)
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

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Deployments

JRES-336

Website	https://www.bco-dmo.org/deployment/628214
Platform	R/V JOIDES Resolution
Report	http://dmoserv3.whoi.edu/data_docs/C-DEBI/cruise_reports/336PR.pdf
Start Date	2011-09-16
End Date	2011-11-16
Description	More information is available from the IODP website: http://iodp.tamu.edu/scienceops/expeditions/midatlantic_ridge_microbio.html

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Project Information

IODP Expedition 336- Mid-Atlantic Ridge Microbiology (Mid-Atl Ridge Microbio)

Coverage: North Pond

This project was funded by a C-DEBI small grant to SW and WZ, by a C-DEBI Postdoctoral Fellowship to CB, and by NSF award OCE-1131671 to WZ.

Project title (SW and WZ) "**Autotrophy and heterotrophy supported by microbial nitrogen cycling in sediments underlying the oligotrophic ocean: A stable isotope study of North Pond porewaters**"

Description from C-DEBI:
As a key element in fundamental biomolecules, the cycling and availability of nitrogen is a central factor governing the extent of ecosystems across the Earth. In the organic-lean sediment porewaters underlying the oligotrophic ocean, where low levels of microbial activity persist despite exceedingly energy-depleted conditions, the extent and modes of nitrogen transformations have not been widely investigated. We used the N and O isotopes of porewater nitrate from the North Pond site in the oligotrophic North Atlantic (North Pond) to provide constraints on the extent of both nitrate production (via nitrification) and consumption (via denitrification). Nitrate accumulates far above bottom seawater concentrations (~21 uM) throughout the sediment column (up to almost ~50 uM) and persists down to the oceanic basement as deep as 90 mbsf, indicating the predominance of aerobic nitrification and remineralization in these sediments. However, large changes in the δ15N and δ18O of nitrate also reveal variable influence of nitrate respiration across the three boreholes.

Combining the N and O isotopes and using an inverse porewater diffusion-reaction model, we estimate rates of nitrification and denitrification throughout the sediment column. Results indicate a range of rates across the three boreholes and are generally consistent with variations observed in profiles of dissolved oxygen at this site. The model also estimates values of the N isotopic composition of newly produced nitrate, which were generally lower than measurements of sinking particulate nitrogen in this region. We suggest that this must be the result of sedimentary-hosted nitrogen fixation supplementing the relatively small organic matter pool derived from the overlying euphotic zone. These findings indicate that the production of organic matter by in situ autotrophy (by both nitrification and nitrogen fixation) must supply a large fraction of the biomass and organic substrate for heterotrophy in these sediments. This work sheds new light on an active nitrogen cycle operating, despite exceedingly low carbon inputs, in the deep sedimentary biosphere.

Project title (CB) "**Determining the rates of denitrification, nitrification, and nitrogen fixation using natural abundance isotope profiles in North Pond sediments**"

Description from C-DEBI:
The sedimentary contribution to the global ocean fixed nitrogen budget is currently under debate. Early studies using the isotopic balance of 15N of nitrate, predicted a large nitrogen loss through sedimentary denitrification and yielding an enormous imbalance in the budget, with nitrogen loss far outweighing sources of nitrogen to the ocean. The major roadblock preventing our ability to estimate the rates of nitrogen metabolisms within the deep biosphere is the difficulty sampling and measuring rates while keeping in situ conditions. Even with the recent technological advances in collecting deep sediments, there is still perturbation of the microbial

community when conducting bottle incubations and adding artificial isotope tracers. To overcome these issues, I plan to use natural abundance stable isotope profiles of multiple nitrogen species to more quantitatively constrain rates of microbial nitrogen metabolism. Stable isotope profiles have the potential to tease apart multiple processes that the concentration profiles alone cannot. In order to do this, however, we need a more in-depth understanding of the isotope systematics of each process under conditions that more closely approximate the low-energy systems manifested in sediments underlying the oligotrophic ocean. Here I plan to conduct multiple incubation experiments designed to measure the isotope systematics during a) coupled denitrification and nitrification and b) benthic nitrogen fixation, under conditions relevant to the deep biosphere.

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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-0939564
NSF Division of Ocean Sciences (NSF OCE)	OCE-1131671

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