Concentrations, d13C and D14C data for DOC and DIC in fluids collected from North Pond Cork Observatories U1382A and U1383C and from bottom seawater in 2012, 2014 and 2017.

Website: https://www.bco-dmo.org/dataset/876729
Data Type: Other Field Results
Version: 1
Version Date: 2022-08-10

Project
» Collaborative Research: A multidimensional approach to understanding microbial carbon cycling beneath the seafloor during cool hydrothermal circulation (Subseafloor Microbial Carbon Cycling)

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

Contributors	Affiliation	Role
Girguis, Peter	Harvard University	Principal Investigator
Shah Walter, Sunita R.	University of Delaware	Co-Principal Investigator, Contact
Soenen, Karen	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Concentrations, d13C and D14C data for DOC and DIC in fluids collected from North Pond Cork Observatories U1382A and U1383C and from bottom seawater in 2012, 2014 and 2017.

Table of Contents

Coverage

Spatial Extent: **N**:22.8127 **E**:-46.0528 **S**:22.7559 **W**:-46.0815
Temporal Extent: 2017-10-11 - 2017-10-15

Dataset Description

These data were published in *(include table #)*:

2012-2014 DIC, DOC, and isotopic DIC parameters are in Table 1, Shah Walter et al., 2018. (Only DOC values originally reported by NOSAMS are included in Table 1, corrected values were not available at the time of publication).

2017 DIC concentrations are in Table 1 of Trembath-Reichert et al. 2021.

Acquisition Description

Samples were taken during cruise R/V Atlantis AT39-01. ROV Jason II dives 1024 – 1035, IODP CORK observatories U1382A, U1383C

Detailed methodology for sample collection, shipboard procedures and sample storage conditions provided in BCO-DMO dataset “Carbon Geochemistry Samples List” (see related datasets)

Procedures for measurement of concentrations, d13C and D14C values of DIC and DOC from fluid samples are described in

Shah Walter, S. R et al. (2018) .

Briefly, DIC samples were transferred from sampling bags through Masterflex Bio-Pharm silicone tubing pre-cleaned with 10% HCl to 100 mL Wheaton wide-mouth reagent bottles with ground-glass stoppers such that turbulence during fluid transfer was minimized. Samples were preserved according to NOSAMS DIC sampling protocol: http://www.whoi.edu/fileserver.do?id=75006&pt=2&p=75096 and stored at room temperature in the dark. DIC samples were submitted to the NOSAMS AMS facility for analysis (https://www2.whoi.edu/site/nosams/). DIC concentration is measured as CO2 yield after acidification and water stripping for fluids sampled in 2012 and 2014 and reported with an uncertainty of 5%. For fluids sampled in 2017, DIC was measured on an AS-C3 analyzer (Apollo Scitech, Newark, DE, USA). After acidification with phosphoric acid, the evolved CO2 was extracted and carried by pure N2 gas to an infrared CO2 detector (Li-Cor 6262). DIC concentrations were calibrated against certified reference material produced by A. G. Dickson (Scripps Institution of Oceanography, San Diego, CA, USA). Each sample was measured in duplicate with repeat concentrations within 0.1% and measurement uncertainty of 2 umol/kg. d13C values are measured on CO2 splits by IRMS and reported with a conservative uncertainty of 0.1‰, higher than each individual measurement. D14C values are measured by AMS and uncertainty is reported for each individual measurement. All isotopic measurements and error estimations were made according to standard NOSAMS protocols.

DOC samples were transferred to 1000-mL amber glass bottles. A parallel set of samples was filtered through pre-combusted GF/F filters to remove particulate matter but these samples yielded more carbon than observed in previous years and it was determined that they were likely to be contaminated. Values reported are from whole, unfiltered fluids which yielded less CO2 than filtered fluids supporting our hypothesis that filtered samples were contaminated. Particles were not observed in the whole fluids during transfer. Frozen DOC samples were submitted to the NOSAMS AMS facility for analysis (https://www2.whoi.edu/site/nosams/). DOC concentrations are measured as CO2 yield after UV-oxidation of samples. d13C values are measured on CO2 splits by IRMS and original values reported with a conservative uncertainty of 0.5‰, higher than each individual measurement. D14C values are measured by AMS and uncertainty is reported for each individual measurement. All measurements and error estimations were made according to standard NOSAMS protocols. NOSAMS revised all previously reported DOC data in 2019 according to new internal estimation and correction for carbon blank in their DOC oxidation procedure. Original and corrected DOC data are both reported in the dataset for samples measured before 2019. For corrected d13C values, individual error estimates are reported as well.

Processing Description

Missing values are from fluids samples not taken in 2012 and 2014.

BCO-DMO processing notes:
* Converted latitude and longitude to decimal degrees

[table of contents | back to top]

Related Publications

Shah Walter, S. R., Jaekel, U., Osterholz, H., Fisher, A. T., Huber, J. A., Pearson, A., … Girguis, P. R. (2018). Microbial decomposition of marine dissolved organic matter in cool oceanic crust. Nature Geoscience, 11(5), 334–339. doi:10.1038/s41561-018-0109-5
Methods

Trembath-Reichert, E., Shah Walter, S. R., Ortiz, M. A. F., Carter, P. D., Girguis, P. R., & Huber, J. A. (2021). Multiple carbon incorporation strategies support microbial survival in cold subseafloor crustal fluids. Science Advances, 7(18), eabg0153. doi:10.1126/sciadv.abg0153
Results

[table of contents | back to top]

Related Datasets

References

Girguis, P., Shah Walter, S. R. (2021) **Inventory of fluid and filter samples collected for carbon composition and isotope analysis from R/V Atlantis cruise AT39-01 at the North Pond CORK Sites U1382A and U1383C during October 2017.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2018-01-12 doi:10.26008/1912/bco-dmo.723493.1 [view at BCO-DMO]
Relationship Description: Dataset describing the specific sampling procedures.

[table of contents | back to top]

Parameters

Parameter	Description	Units
sampling_year	Year of sampling	unitless
location	Sampling location	unitless
latitude	Latitude of sampling location	decimal degrees, south is negative
longitude	Longitude of sampling location	decimal degrees, west is negative
sample_date	sample date in ISO format (UTC time)	unitless
DIC_conc	Dissolved Inorganic Carbon concentration of water sample	mmol/kg (millimolar)
delta_13C_DIC	delta 13C (d13C) is the ratio of stable isotopes 13C:12C relative to the PeeDee Belemnite standard	parts per thousand, per mil (‰)
delta_13C_DIC_error	d13C measurement error	parts per thousand, per mil (‰)
delta_14C_DIC	Delta^14C (D14C)/Radiocarbon is the per mil deviation of 14C/12C ratio relative to the standard of 1950 atmospheric 14C concentration, normalized to a d13C of -25 per mil	parts per thousand, per mil (‰)
delta_14C_DIC_error	D14C measurement error	parts per thousand, per mil (‰)
DIC_NOSAMS_accession_number	Radiocarbon DIC sample ID (National Ocean Sciences Accelerator Mass Spectrometry (NOSAMS) facility accession number)	unitless
DOC_conc	Dissolved Organic Carbon concentration of water sample	micromole (µM)
delta_13C_DOC_original	delta 13C (d13C) is the ratio of stable isotopes 13C:12C relative to the PeeDee Belemnite standard originally reported by NOSAMS	parts per thousand, per mil (‰)
delta_13C_DOC_original_error	d13C measurement error	parts per thousand, per mil (‰)
Delta_14C_DOC_original	Delta^14C (D14C)/Radiocarbon is the per mil deviation of 14C/12C ratio relative to the standard of 1950 atmospheric 14C concentration, normalized to a d13C of -25 per mil originally reported by NOSAMS	parts per thousand, per mil (‰)
Delta_14C_DOC_original_error	D14C measurement error originally reported by NOSAMS	parts per thousand, per mil (‰)
DOC_NOSAMS_accession_number_original	Radiocarbon DOC sample ID (NOSAMS accession number) for original values	unitless
delta_13C_DOC_corrected	delta 13C (d13C) is the ratio of stable isotopes 13C:12C relative to the PeeDee Belemnite standard, corrected value reported by NOSAMS	parts per thousand, per mil (‰)

delta_13C_DOC_corrected_error	d13C measurement error	parts per thousand, per mil (‰)
Delta_14C_DOC_corrected	Delta^14C (D14C)/Radiocarbon is the per mil deviation of 14C/12C ratio relative to the standard of 1950 atmospheric 14C concentration, normalized to a d13C of -25 per mil corrected value reported by NOSAMS	parts per thousand, per mil (‰)
Delta_14C_DOC_corrected_error	D14C measurement error originally reported by NOSAMS	parts per thousand, per mil (‰)
DOC_NOSAMS_accession_number_corrected	Radiocarbon DOC sample ID (NOSAMS accession number) for corrected values	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Infrared CO2 detector (Li-Cor 6262)
Generic Instrument Name	LI-COR LI-6262 Gas Analyzer
Generic Instrument Description	The LI-6262 CO2/H2O Gas Analyzer measures CO2 flux in the environment. It was manufactured by LI-COR Biosciences Inc. (licor.com) from 1990 through 2005 and serial Numbers for this model have the prefix of IRG3-XXXX. The LI-6262 is a differential, non-dispersive, infrared (NDIR) gas analyzer. The CO2 and H2O measurements are based on the difference in absorption of infrared (IR) radiation passing through two gas sampling cells. The reference cell is used for a gas of known CO2 or H2O concentration, and the sample cell is used for a gas of unknown concentration. Infrared radiation is transmitted through both cell paths, and the output of the analyzer is proportional to the difference in absorption between the two (LI-6262 CO2/H2O Analyzer Operating and Service Manual, Publication Number 9003-59, March, 1996, pg 18).

Dataset-specific Instrument Name	AS-C3 analyzer (Apollo Scitech, Newark, DE, USA)
Generic Instrument Name	Apollo SciTech AS-C3 Dissolved Inorganic Carbon (DIC) analyzer
Dataset-specific Description	AS-C3 analyzer (Apollo Scitech, Newark, DE, USA)
Generic Instrument Description	A Dissolved Inorganic Carbon (DIC) analyzer, for use in aquatic carbon dioxide parameter analysis of coastal waters, sediment pore-waters, and time-series incubation samples. The analyzer consists of a solid state infrared CO2 detector, a mass-flow controller, and a digital pump for transferring accurate amounts of reagent and sample. The analyzer uses an electronic cooling system to keep the reactor temperature below 3 degrees Celsius, and a Nafion dry tube to reduce the water vapour and keep the analyzer drift-free and maintenance-free for longer. The analyzer can handle sample volumes from 0.1 - 1.5 milliliters, however the best results are obtained from sample volumes between 0.5 - 1 milliliters. It takes approximately 3 minutes per analysis, and measurement precision is plus or minus 2 micromoles per kilogram or higher for surface seawater. It is designed for both land based and shipboard laboratory use.

[table of contents | back to top]

Deployments

AT39-01

Website	https://www.bco-dmo.org/deployment/723337
Platform	R/V Atlantis
Report	http://datadocs.bco-dmo.org/docs/Subseafloor_Microbial_Carbon_Cycling/data_docs/North_Pond_2017_Expedition%20Report_FINAL.pdf
Start Date	2017-10-02
End Date	2017-11-02

[table of contents | back to top]

Project Information

Collaborative Research: A multidimensional approach to understanding microbial carbon cycling beneath the seafloor during cool hydrothermal circulation (Subseafloor Microbial Carbon Cycling)

Coverage: The “North Pond” sedimented site in the Mid-Atlantic ridge. This is an IODP study site. The coordinates are 22 ° and 23°N by 44°30 ' to 46°20'W

NSF abstract:

The global ocean comprises Earth’s largest microbiome, with at least half of the ocean’s microbial biomass occurring beneath the ocean floor. In particular, oceanic crust encompasses the largest aquifer on Earth, with a liquid volume equal to approximately 2% of the ocean’s volume. It also harbors a substantial reservoir of microbial life that may influence global-scale biogeochemical cycles. This project investigates this largest actively flowing aquifer system on Earth- the fluids circulating through oceanic crust underlying the oceans and sediments. Despite advancing knowledge about life in the deep ocean, the understanding of microorganisms in the rocky oceanic crust and the fluids flowing through it remains rudimentary. This project is focused on understanding the linkages between microbial activity and the cycling of carbon in the cool, subseafloor biosphere. The balance between organic carbon-consuming and organic carbon-producing metabolisms within the crustal biosphere will be determined using seafloor observatories put in place by the International Ocean Discovery Program (IODP) on the flanks of the Mid-Atlantic Ridge, likely representative of the majority of global hydrothermal fluid circulation. The rates of microbial transformations of carbon will be determined using both geochemical and biological approaches. Results will help establish the extent to which microbially-mediated processes in the subseafloor influence carbon cycling in the ocean. This work will represent the first comprehensive description of carbon cycling in the cold oxic crustal aquifer. Two female postdocs will be supported on the grant, and both high school and community college students will also be involved through collaborations with Cape Cod Community College and Cambridge-Rindge and Latin School. The goal is to promote science, technology, engineering and math literacy among high-school and community college students through hand-on research experiences, peer-to-peer mentoring, and professional development opportunities.

The goal of the project is to answer the question "is the cool crustal subseafloor biosphere net autotrophic or net heterotrophic?" The focus of the effort is at North Pond, an isolated sediment pond located on ridge flank oceanic crust 7-8 million years old on the western side of the Mid-Atlantic Ridge. The two objectives of the project are to:

1. Characterize suspended particles in subseafloor fluids with respect to their inorganic and organic carbon content, and natural ^{14}C and ^{13}C isotopic ratios, to determine microbially-mediated fluxes and processes.

2. Characterize the net influence of particle-associated and free-living microbial communities on subseafloor fluid primary production and remineralization, as well as the taxon-specific contributions to these same processes.

The integration of isotope geochemical and molecular biological approaches represents a significant cross-disciplinary advance in the understanding of the microbial ecology and geochemistry of the subseafloor biosphere in young oceanic crust and their role in maintaining global deep-sea redox balance. Expected outcomes include identifying signatures of autotrophic and heterotrophic metabolism in particle-associated and free-living subseafloor microbial communities as well as quantification of autotrophic and heterotrophic metabolism and associated taxon-abundances to provide insights into the net and specific microbial processes in crustal fluids on carbon fluxes.

[table of contents | back to top]

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1635365

[table of contents | back to top]