Protein assay of proteinaceous material in pelagic sediment from the North Atlantic gyre, South Pacific gyre, and Peru Basin from cruises KN223, KNOX02RR, and ODP leg 201 between 2002 and 2013

Website: https://www.bco-dmo.org/dataset/782742
Data Type: Cruise Results
Version: 1
Version Date: 2020-06-15

Project
» Geochemical controls on organic carbon quantity and quality in the deep subsurface (Org C Sed II)
» Elucidating the extent and composition of mineral-hosted carbon in the deep biosphere (Org C Sed I)

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

Contributors	Affiliation	Role
Estes, Emily	Texas A&M University (TAMU)	Principal Investigator
Hansel, Colleen	Woods Hole Oceanographic Institution (WHOI)	Co-Principal Investigator
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Protein assay of proteinaceous material in pelagic sediment from the North Atlantic gyre, South Pacific gyre, and Peru Basin from cruises KN223 (R/V Knorr), KNOX02RR (R/V Roger Revelle), and ODP leg 201 between 2002 and 2013. Sediment samples were taken with gravity corers, multi corers, piston and advanced piston corers (APC).

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Coverage

Spatial Extent: **N**:33.4833 **E**:-50.62 **S**:-38.0617 **W**:-165.6433
Temporal Extent: 2002 - 2013

Dataset Description

Protein assay of proteinaceous material in pelagic sediment from the North Atlantic gyre, South Pacific gyre, and Peru Basin from cruises KN223 (R/V Knorr), KNOX02RR (R/V Roger Revelle), and ODP leg 201 between 2002 and 2013. Sediment samples were taken with gravity corers, multi corers, piston and advanced piston corers (APC).

These data were published in Estes et al. (2019) as Figure 1.

Methods & Sampling

Sediment samples were stored at 4°C prior to analysis. Proteinaceous material was extracted and quantified with Qubit fluorescent reagent (Life Technologies), following Estes et al. (2016) as modified from Ehrenreich and Widdel (1994).

Assay was quantified using bovine serum albumin standard (Bio-Rad).

See Estes el al. 2019, for complete methods.

Data Processing Description

BCO-DMO Data Manager Processing Notes:
* exported data in xlsx file "Estes protein data.xlsx" to csv file
* added a conventional header with dataset name, PI name, version date
* modified parameter names to conform with BCO-DMO naming conventions
* blank values in this dataset are displayed as "nd" for "no data." nd is the default missing data identifier in the BCO-DMO system.
* latitude and longitude in degrees decimal minutes converted to decimal degrees then rounded to 5 decimal places.
* protein and prot_stdev rounded to two decimal places
* date format converted to ISO 8601 format yyyy-mm-dd

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Data Files

File
protein.csv (Comma Separated Values (.csv), 7.93 KB) MD5:326b12f5a8382be156be6ada87669fe4 Primary data file for dataset ID 782742

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Related Publications

Ehrenreich, A., & Widdel, F. (1994). Anaerobic oxidation of ferrous iron by purple bacteria, a new type of phototrophic metabolism. Appl. Environ. Microbiol., 60(12), 4517-4526.
https://aem.asm.org/content/aem/60/12/4517.full.pdf
Methods

Estes, E. R., Andeer, P. F., Nordlund, D., Wankel, S. D., & Hansel, C. M. (2016). Biogenic manganese oxides as reservoirs of organic carbon and proteins in terrestrial and marine environments. Geobiology, 15(1), 158–172. doi:10.1111/gbi.12195
Methods

Estes, E. R., Pockalny, R., D'Hondt, S., Inagaki, F., Morono, Y., Murray, R. W., … Hansel, C. M. (2019). Persistent organic matter in oxic subseafloor sediment. Nature Geoscience, 12(2), 126–131. doi:10.1038/s41561-018-0291-5
Results

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Parameters

Parameter	Description	Units
location	Sample origin	unitless
expedition	Cruise name	unitless
site	Site number	unitless
latitude	Latitude	decimal degrees
longitude	Longitude	decimal degrees
water_depth	Water depth	meters (m)
core_type	Coring device used	unitless
depth	Sample depth (meters below seafloor)	meters (m)
protein	Content of proteinaceous material	micrograms of protein per milligram of sediment (µg protein/mg sediment)
prot_stdev	Standard deviation of the content of proteinaceous material (triplicate analyses).	micrograms of protein per milligram of sediment (µg protein/mg sediment)
date	date sample collection in ISO 8601 format yyyy-mm-dd	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	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	
Generic Instrument Name	Gravity Corer
Generic Instrument Description	The gravity corer allows researchers to sample sediment layers at the bottom of lakes or oceans. The coring device is deployed from the ship and gravity carries it to the seafloor. (http://www.whoi.edu/instruments/viewInstrument.do?id=1079).

Dataset-specific Instrument Name	
Generic Instrument Name	Multi Corer
Generic Instrument Description	The Multi Corer is a benthic coring device used to collect multiple, simultaneous, undisturbed sediment/water samples from the seafloor. Multiple coring tubes with varying sampling capacity depending on tube dimensions are mounted in a frame designed to sample the deep ocean seafloor. For more information, see Barnett et al. (1984) in Oceanologica Acta, 7, pp. 399-408.

Dataset-specific Instrument Name	
Generic Instrument Name	Piston Corer
Generic Instrument Description	The piston corer is a type of bottom sediment sampling device. A long, heavy tube is plunged into the seafloor to extract samples of mud sediment. A piston corer uses a "free fall" of the coring rig to achieve a greater initial force on impact than gravity coring. A sliding piston inside the core barrel reduces inside wall friction with the sediment and helps to evacuate displaced water from the top of the corer. A piston corer is capable of extracting core samples up to 90 feet in length.

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Deployments

KN223

Website	https://www.bco-dmo.org/deployment/567408
Platform	R/V Knorr
Start Date	2014-10-25
End Date	2014-12-02

KNOX02RR

Website	https://www.bco-dmo.org/deployment/567923
Platform	R/V Roger Revelle
Start Date	2006-12-17
End Date	2007-01-27

JRES-201

Website	https://www.bco-dmo.org/deployment/626163
Platform	R/V JOIDES Resolution
Report	http://dmoserv3.whoi.edu/data_docs/C-DEBI/cruise_reports/201PREL-1.pdf
Start Date	2002-01-27
End Date	2002-03-29
Description	Leg 201 Controls on Microbial Communities in Deeply Buried Sediments, Eastern Equatorial Pacific and Peru Margin Sites 1225-1231 27 January-29 March 2002 Cruise report obtained from http://www-odp.tamu.edu/publications/pubs.htm

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Project Information

Geochemical controls on organic carbon quantity and quality in the deep subsurface (Org C Sed II)

Website: https://www.darkenergybiosphere.org/award/3d-spatial-mapping-of-the-energetic-return-of-1000-metabolisms-within-the-compositional-variation-of-oceanic-crusts-near-mid-ocean-ridges/

Coverage: North Atlantic gyre, South Pacific gyre

Abstract from the C-DEBI project page:

Sediment underlying ocean gyres receives minimal input of fresh organic matter yet sustains a small but active heterotrophic microbial community. The concentration and composition of the organic carbon (OC) available to this deep biosphere however is unknown. We analyzed the content and composition of OC in pelagic sediment in order to identify mechanism(s) that dictate the balance between OC preservation and utilization by microorganisms. Sediment cores from the North Atlantic gyre (KN223), South Pacific Gyre (Knox02-RR), and Peru Basin (IODP site 1231) allowed for a global comparison and a test of how sediment lithology and redox state affect OC preservation. OC was present in low concentrations in all samples (0.01—0.61%), at depths up to 112 meters below seafloor and estimated sediment ages of up to 50 million years. Synchrotron-based near edge X-ray absorption fine structure (NEXAFS) spectroscopy was conducted on over 100 samples, one of the first applications of NEXAFS to sedimentary environments. NEXAFS revealed an OC reservoir dominated by amide and carboxylic functionalities in a scaffolding of O-alkyl and aliphatic carbons. Detection of extractable, extracellular proteins supports this composition and suggests that sedimentary OC is protein-derived. This composition was common across all sites and depths, implicating physical rather than chemical mechanisms in OC preservation on long timescales. This study thereby points to physical access rather than energy or metabolic potential as a key constraint on subsurface heterotrophic life.

Elucidating the extent and composition of mineral-hosted carbon in the deep biosphere (Org C Sed I)

Website: https://www.darkenergybiosphere.org/award/elucidating-the-extent-and-composition-of-mineral-hosted-carbon-in-the-deep-biosphere/

Coverage: North Atlantic gyre, South Pacific gyre

Abstract from the C-DEBI project page:

Minerals have recently been identified as a primary host for organic carbon (OC) within marine sediments. This strong physical and chemical carbon-mineral association is believed to reduce, and in some cases completely eliminate, the bioavailablilty of this carbon for microbial life. The paucity of information regarding the nature of

this carbon-mineral association and the composition of the hosted carbon, however, precludes our ability to predict the ultimate fate of this OC and its involvement in deep subsurface life. Here, we addressed this knowledge gap by using a suite of bulk and spatially-resolved geochemical and mineralogical techniques to characterize OC-mineral associations within the deep subsurface. We characterized sediment samples collected on the 2014 North Atlantic long coring expedition (KN223) in the western subtropical North Atlantic that included three geochemically distinct long cores to a depth of 24-30 m and spanned OC-limited oxic to anoxic sediments. We find measurable and relevant OC concentrations throughout the sediment cores, that decreases linearly over ~25 meters burial depth, from ~0.15 to 0.075 mol OC/kg solid. OC within the sediments is compositionally complex on both a macro- and micro-scale, spanning a gradient of lability even at depth. Proteins are observed throughout the sediment depth profiles, where they appear to constitute a substantial fraction of the TOC. Correspondingly, a low C:N ratio is observed, consistent with proteinaceous carbon within the sediments. In sum, these findings point to a substantial mineral-hosted OC reservoir within the deep subsurface that may fuel the deep biosphere and select for protein-based heterotrophy.

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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

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