Pore water geochemistry from sediments collected on cruise OC1703A aboard R/V Oceanus and cruise AT36 aboard R/V Atlantis

Website: https://www.bco-dmo.org/dataset/862499
Data Type: Cruise Results
Version: 1
Version Date: 2021-10-06

Project
» Nitrogen Fixation in Deep-Sea Sediments (Deep Sediment N Fix)

Contributors	Affiliation	Role
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Abstract
This dataset includes pore water geochemistry from sediments collected on cruise OC1703A aboard R/V Oceanus in March 2017 and on cruise AT36 aboard R/V Atlantis in July-August 2016. Sediment cores were collected using an MC-800 multicore and an MC-400 multicore.

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Coverage

Spatial Extent: **N**:39.9002 **E**:-69.2638 **S**:35.6891 **W**:-124.9221
Temporal Extent: 2016-07-28 - 2017-03-22

Methods & Sampling

Sediment cores were collected in the northwest Pacific Ocean off the coast of San Francisco, CA on the R/V Oceanus during cruise OC1703A in March 2017 and in the northeast Atlantic off the coast of Woods Hole, MA on the R/V Atlantis during cruise AT36 in July 2016. Sediment cores in the northwest Pacific were 15–30 cm long and collected at five sites (100–4475 water depths) using an MC-800 multicore (Ocean Instruments). Sediment cores in the northeast Atlantic were 15 cm long and collected at two sites (1252–1496 water depth) using an MC-400 multicore (Ocean Instruments). Both multicores were modified with Go-Pro cameras in custom pressure housing to provide real-time video feeds and guide sampling (MISO Facility, Woods Hole Oceanographic Institute). Cores were stored at 4ºC for ≤24 hours until they were sectioned on board in 2.5, 3 or 5 cm depth increments. At each site, sediment porewater was extracted from triplicate cores in the Pacific and single cores in the Atlantic using either a porewater pressing bench (two cores/site in the Pacific; KC Denmark Research Equipment, Silkeborg, Denmark) under a stream of argon gas or Rhizon samplers (one core/site in the Pacific, all cores in the Atlantic; Rhizosphere Research Products, Wageningen, The Netherlands). Extracted water was either preserved with zinc acetate or filtered via 0.2 µm filters and frozen at −20°C.

Concentrations of nitrate, nitrite, ammonium, sulfate, sulfide, phosphate, bromide, and acetate were measured in pore water extracted from two cores at each site. Ammonium concentrations were obtained using a colorimetric assay (Bower et al.,1980). Phosphate concentrations were obtained using a Malachite Green Phosphate Assay Kit (BioAssay Systems; Hayward, CA; Cat# POMG-25H), following the manufacturer's instructions. The analysis of nitrite and nitrate was performed using a microphotometry assay (Schnetger and Lehners, 2014). Concentrations of sulfide were measured in pore water preserved with zinc acetate via the colorimetric Cline Assay (Cline 1969). Optical densities of ammonium, phosphate, nitrite, nitrate and sulfide were obtained with a Lab BioTek Synergy HT microplate reader (Winooski, VT). Check standards for each nutrient were run in duplicate or triplicate along with samples. Sulfate, bromide, acetate and formate concentrations were determined with a Dionex DX-500 Ion Chromatograph, AS11 column, 5-50% sodium hydroxide gradient (Dionex Corporation, Sunnyvale CA) in the Stanford Environmental Measurements Facility. Samples and standards were diluted with ultrapure water before analysis. Check standards were analyzed every 10–15 samples. Oxygen concentrations were measured directly in the sediment through pre-drilled holes in the core tubes using an optical oxygen meter, FirestingO2 (FSO2-4, PyroScience, Aachen, Germany), and the robust oxygen probe (OCROB10, PyroScience). A two-point calibration was performed (0 and 100% air saturation), and the measurement was compensated for temperature and ambient pressure using internal or external sensors, as well as seawater salinity (35 g/L).

Data Processing Description

BCO-DMO Processing:
- renamed fields to conform with BCO-DMO naming conventions;
- converted longitude negative values to indicate West direction.

Missing Data Notation:
blq = below limit of quantification;
nm = no measurement;
nd = no data/not applicable (used in Notes column only);
ppt = precipate formed & no data collected (used inPO4_uM column only).

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Data Files

File
porewater_chem.csv (Comma Separated Values (.csv), 20.11 KB) MD5:c3f6d391dce824b7a645f8d6bccb6610 Primary data file for dataset ID 862499

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Related Publications

Bower, C. E., & Holm-Hansen, T. (1980). A Salicylate–Hypochlorite Method for Determining Ammonia in Seawater. Canadian Journal of Fisheries and Aquatic Sciences, 37(5), 794–798. doi:10.1139/f80-106
Methods

Cline, J. D. (1969). Spectrophotometric Determination of Hydrogen Sulfide in Natural Waters. Limnology and Oceanography, 14(3), 454–458. doi:10.4319/lo.1969.14.3.0454
Methods

Schnetger, B., & Lehners, C. (2014). Determination of nitrate plus nitrite in small volume marine water samples using vanadium(III)chloride as a reduction agent. Marine Chemistry, 160, 91–98. doi:10.1016/j.marchem.2014.01.010
Methods

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Parameters

Parameter	Description	Units
Cruise	Cruise ID number	unitless
ISO_Date_Local	Date (local) in format YYYY-MM-DD	unitless
Latitude	Sampling latitude	decimal degrees North
Longitude	Sampling longitude	decimal degrees East
Deployment	Deployment number	unitless
Water_Depth_m	Sampling water depth	meters (m)
Core	Multicore number	unitless
Depth_cm	Sampling sediment depth	centimeters (cm)
NH4_uM	Ammonium concentration	micromolar (uM)
PO4_uM	Phosphate concentration. Note: there is one row with a value of "ppt"; this means precipitate formed; no data collected.	micromolar (uM)
Nox_uM	NOx concentration	micromolar (uM)
NO2_uM	Nitrite concentration	micromolar (uM)
NO3_uM	Nitrate concentration	micromolar (uM)
Sulfide_mM	Sulfide concentration	millimolar (mM)
Bromide_mM	Bromide concentration	millimolar (mM)
Sulfate_mM	Sulfate concentration	millimolar (mM)
Acetate_mM	Acetate concentration	millimolar (mM)
Formate_mM	Formate concentration	millimolar (mM)
Oxygen_mg_L	Oxygen concentration	milligrams per liter (mg/L)
Notes	Comments/notes	unitless

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Instruments

Dataset-specific Instrument Name	Go-Pro camera
Generic Instrument Name	Camera
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

Dataset-specific Instrument Name	Dionex DX-500 Ion Chromatograph, AS11 column
Generic Instrument Name	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....)

Dataset-specific Instrument Name	porewater pressing bench (KC Denmark Research Equipment, Silkeborg, Denmark)
Generic Instrument Name	KC Pore-Water Pressing Bench
Generic Instrument Description	The KC Pore-water pressing bench, made by KC Denmark Research Equipment, allows pore-water extraction of any kind of sediments, from sediments rich in organic material, to sandy sediments. Sediment cores are segmented and placed in the pressing house, which is closed by means of the handle on top of the house. An over-pressure is applied (fed-in) at the reduction valve and the valves of the houses in operation are opened. The resulting compression of the sediment matrix leads to expelling of the pore-water, which is sampled in containers beneath the pressing house. Operation in a glove bag prevents atmospheric contamination with, for example, oxygen, so anaerobic analysis of the pore-water is possible. The standard cylinders are made from black Polyoxymethylene (POM). However, the cylinders and all accessories are also available as AISI 316 stainless steel for special purposes. The pressing bench consists of 5 pressing houses, each 100 ml. They can hold a maximum sample diameter of 40 mm. The instrument has a maximum operating pressure of 4 bar (400 kPa).

Dataset-specific Instrument Name	MC-800 multicore (Ocean Instruments)
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	MC-400 multicore (Ocean Instruments)
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	FirestingO2 (FSO2-4, PyroScience, Aachen, Germany)
Generic Instrument Name	Oxygen Sensor
Generic Instrument Description	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed

Dataset-specific Instrument Name	robust oxygen probe (OCROB10, PyroScience)
Generic Instrument Name	Oxygen Sensor
Generic Instrument Description	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed

Dataset-specific Instrument Name	Lab BioTek Synergy HT microplate reader (Winooski, VT)
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	Rhizon samplers (Rhizosphere Research Products, Wageningen, The Netherlands)
Generic Instrument Name	Sediment Porewater Sampler
Generic Instrument Description	A device that collects samples of pore water from various horizons below the seabed.

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Deployments

OC1703A

Website	https://www.bco-dmo.org/deployment/717423
Platform	R/V Oceanus
Start Date	2017-03-14
End Date	2017-03-23
Description	See additional cruise information from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/OC1703A

AT36

Website	https://www.bco-dmo.org/deployment/862503
Platform	R/V Atlantis
Start Date	2016-07-28
End Date	2016-08-07
Description	See additional cruise information from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/AT36

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Project Information

Nitrogen Fixation in Deep-Sea Sediments (Deep Sediment N Fix)

Coverage: California Shelf (36,-123)

NSF Award Abstract:
Life requires nitrogen for growth. Atmospheric nitrogen (N2) is the most abundant form of nitrogen on the surface of the planet, but most organisms cannot assimilate N2 directly. Habitats can therefore be nitrogen limited, meaning the demand for "bioavailable" nitrogen exceeds the supply, and its availability controls the overall growth and productivity of the community. A small subset of microorganisms, termed diazotrophs, convert N2 to bioavailable forms of nitrogen, including ammonium and nitrogenous organic matter, in a process known as N2 fixation. Diazotrophs are the largest natural source of bioavailable nitrogen on the planet, and the rate at which they fix N2 can control the rates at which other important microbial processes occur, such as the production and consumption of greenhouse gases. Understanding diazotrophs in the environment - their identity, distribution, activity levels, and biogeochemical controls - is therefore essential to understanding overall microbial community activity and biogeochemical cycling. The goal of this project is to characterize N2 fixation in deep-sea sediments, a generally understudied but expansive habitat, covering nearly two thirds of our planet. The project will have broader impacts via educational outreach, support and training of early career scientists, and scientific impact: since rates of marine methane, carbon dioxide, and nitrous oxide cycling are affected by nitrogen availability, the results will inform our understanding of greenhouse gas cycling in the marine environment, and therefore climate stability, a topic central to global security.

N2 fixation is a critical and intensely studied metabolism in the marine photic zone. Much less is known about N2 fixation in deep-sea sediments, but it could be an important factor in both benthic productivity and ocean-scale elemental cycling. Several observations have suggested or directly detected N2 fixation at localized areas of enhanced productivity on the seafloor (e.g., methane seeps and hydrothermal vents), raising the possibility that deep-sea N2 fixation is widespread. However, few measurements of N2 fixation have been made outside of these anomalous areas, and thus little is known about N2 fixation in the vast majority of the deep ocean floor. Preliminary data suggest N2 fixation does occur in typical deep marine sediment, and is mediated by a diverse set of yet unidentified microorganisms. This project will combine techniques from molecular biology and geochemistry to systematically investigate N2 fixation in representative deep-sea sediments collected along a depth profile (500 to 4500 m water depth) offshore California. The project will determine the (1) rates and distribution of N2 fixation (2) abundance, diversity, and distribution of genes and transcripts associated with N2 fixation (nif) (3) phylogenetic identity of the biological mediators (diazotrophs) and (4) physiochemical controls on diazotrophic community structure and activity. For context, the activity of the non-diazotrophic bacterial community will also be characterized. The results may lead to upward revisions of the estimates of new nitrogen production in the seafloor, and therefore change our understanding of the current balance of the marine nitrogen cycle. Together, this hypothesis-driven characterization of N2 fixation in deep-sea sediments will shed light on an expansive, climatically important, and traditionally understudied habitat, and facilitate more accurate extrapolation of the rates and distribution of N2 fixation on the whole seafloor as well as the metabolic response of the seafloor community to environmental change.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1634297

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