Size fractionated organic carbon and nitrogen concentration and stable isotopes from water column of the East Pacific Rise in April 2019 on the R/V Atlantis cruise AT42-09

Website: https://www.bco-dmo.org/dataset/948709
Data Type: Cruise Results
Version: 1
Version Date: 2025-02-04

Project
» Collaborative Research: From hot to cold in the dark - shifts in seafloor massive sulfide microbial communities as physical and geochemical conditions change after venting ceases (Hot2cold Vents)

Contributors	Affiliation	Role
Cram, Jacob A.	University of Maryland Center for Environmental Science (UMCES/HPL)	Principal Investigator
Fuchsman, Clara	University of Maryland Center for Environmental Science (UMCES/HPL)	Co-Principal Investigator
Tully, Benjamin	University of Southern California (USC)	Scientist
Huanca Valenzuela, Paulina	University of Maryland Center for Environmental Science (UMCES/HPL)	Student
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
On R/V Atlantic cruise AT42-09 in April 2019, size fractionated suspended particulate organic matter samples from the water column at the East Pacific Rise (9°50'N 104°18.14'W) were obtained by opening the bottom of the Niskin bottle to ensured that particles that had sunk below the spigot were included. Between 100 and 120 L of water was gravity filtered, in sequence, through nylon mesh (142 mm diameter) of decreasing pore size (500, 180, 53, 20 µm and 5 µm mesh). The resuspended particulate matter from each sample and size class was collected by vacuum filtration through a 1.2 µm nominal pore size, pre-combusted GF/C glass fiber filter. Samples were wafted with HCl overnight to remove carbonate and sent to the UC Davis Stable Isotope Facility for C and N analysis concentration and stable isotope analysis. The purpose of these samples was were used to create particle size to carbon and nitrogen relationships for models, while gaining insights into the origins and fate of particulate organic matter in the ocean. Additionally, these organic matter fractions are directly linked to 16S rRNA amplicon data. 16S rRNA sequence amplicons exactly corresponding to this organic matter data are deposited in SRA (Short Read Archive) under BioProject PRJNA1191024. Jacob Cram conceived of the idea. Benjamin Tully of Center for Dark Energy Biosphere Investigations, University of Southern California oversaw sample collection. Paulina Huanca Valenzuela and Clara Fuchsman prepped the samples in the laboratory and analyzed the data.

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Coverage

Location: East Pacific Rise water column 9.85°N 104.30°W Depth profile
Spatial Extent: **Lat**:9.85 **Lon**:-104.3
Temporal Extent: 2019-04-06 - 2019-04-11

Dataset Description

These data were supported by NSF award OCE-1756339 and Horn Point Laboratory startup funds.

Results publication in review:
Fuchsman, C.A. and Cram, J.A. (in review) Size fractionated suspended organic carbon and nitrogen from the offshore Eastern Tropical North Pacific Oxygen Deficient Zone suggest contributions of picocyanobacteria and vertically migrating metazoans to organic matter. Global Biogeochemical Cycles
*preprint available at ESS Open Archive (Fuchsman & Cram 2024, doi:10.22541/essoar.173046855.50289201/v1)

Methods & Sampling

For size fractionated suspended particulate organic matter, on R/V Atlantic cruise AT42-09 in April 2019, samples were obtained from Niskin bottles but were collected by opening the bottom of the Niskin bottle into an acid cleaned bucket. This ensured that particles that had sunk below the spigot of the Niskin bottle were included. Between 100 and 120 L of water was gravity filtered, in sequence, through nylon mesh (142 mm diameter) of decreasing pore size (500, 180, 53, 20 µm) and a subset of this 20 µm filtered water (~20 L) was then filtered through a 5 µm mesh. For mesh sizes 20 µm and above, the large diameter of the mesh and abundance of functional pore-space prevented clogging, and water flowed through the mesh quickly, indicating that clogging did not occur. Water filtered more slowly through the 5 µm mesh (on the order of 30 minutes). If flow decreased substantially, the mesh was back-rinsed (see below) before additional water was passed through the mesh. After filtration, each nylon mesh was back rinsed with ~500 ml of prefiltered “rinse water” to produce a resuspension of particulate matter from particles from each size class. The “rinse water” had been generated during transit by pumping surface water in sequence through water filters of size 10, 5, 1 µm to remove particles, followed by a 0.2 µm filter (Pall AcroPak 1500 Capsule with a Supor Polyethersulfone membrane) capsule which removes bacteria. After back-rinsing, the resuspended particles were split with one half used for particulate matter measurements. In all cases the actual volumes were carefully recorded and used for normalization during analysis. The resuspended particulate matter from each sample and size class was collected by vacuum filtration through a 1.2 µm nominal pore size, 25 mm diameter, GF/C glass fiber filter (Whatman WHA1822025). These filters had been previously pre-combusted for at least two hours at 400°C. Two depths were sampled per day and multiple days were combined to represent each station with seven depths sampled total with 92 m sampled twice on different days (April 6 and April 9). Samples were frozen after collection and shipped frozen.

At Horn Point Laboratory, samples were wafted with HCl overnight to remove carbonate, dried at 40°C, packed in both silver and tin capsules, and sent to the UC Davis Stable Isotope Facility for C and N analysis utilizing an Elemental Analyzer (Elementar Vario EL Cube) attached to an Isotope Ratio Mass Spectrometer (Isoprim VisION). Blank combusted GF/C filters were included in analyses and did not show measurable material.

Data Processing Description

ug C and ug N were converted to concentration in Microsoft Excel using the volume of water filtered.

BCO-DMO Curation Notes

* Sheet 1 of submitted file "EPR_2019_size_fractionated_POM.xlsx" was imported into the BCO-DMO data

system as a draft version of this dataset and sent for review to the data submitter.
* To correctly type numeric columns, upon import, values in the table "missing" were interpreted as missing data identifiers. They will display as BCO-DMO default missing data as further described below. An additional Comment column was added with "Filter lost (see Problems/Issues section)" for those rows that contained "missing" values. An additional Carbon_BDL_flag column was added to contain "BDL" values that were within the Carbon column.
** In the BCO-DMO data system missing data identifiers are displayed according to the format of data you access. For example, in csv files it will be blank (null) values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as blank (null) values.

* Completely blank rows removed within table.

* Date converted to ISO 8601 format

* Lat lon converted to decimal degrees (south and west are negative, degree symbols and directional NSEW removed)

* Supplemental reference table was attached without format changes.

* 2025-02-03. Data were re-imported for this dataset from "948709_v1_epr-pom_2019-sizefrac_fixed_CF.csv". The data submitter revised data to fix column alignment issue in provided file. Carbon_BDL_flag was actually d15N_BDL_flag so renamed for accuracy.

* 2025-02-04. Data were re-imported for this dataset from "948709_v1_epr-pom_2019-sizefrac_fixed2.csv." After final review, this will the first published version of this dataset "version 1" and will appear in this dataset as "948709_v1_epr-pom_2019-sizefrac.csv" This revision provides more resolution for values (less rounding) and an additional BDL flag column for C_to_N column.
* Date column format changed to ISO format.
* size fraction "5-20" changed to "20-May" to fix an inadvertent formatting error in the revised data file 948709_v1_epr-pom_2019-sizefrac_fixed2.csv

Problem Description

One filter was lost, corresponding to the >500 µm size fraction for 275 m.
There are 4 samples where the N was below the detection limit for 15N:
92 m April 6th size fraction >500 um
92 m April 9th size fraction >500 um
490 m size fraction > 500 um
527 m size fraction 180-500 um

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Data Files

File
EPR Size-fractioned POM filename: 948709_v1_epr-pom_2019-sizefrac.csv (Comma Separated Values (.csv), 2.83 KB) MD5:e9596612520af9895c76c0aa4cbdff49 Primary data file for dataset ID 948709, version 1. Size fractionated organic carbon and nitrogen concentration and stable isotopes from the EPR in April 2019 for the following fractions: 5-20, 20-53, 53-180, 180-500, >500 um.

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Supplemental Files

File
Isotopic Reference data filename: EPR_POM_Standard_information.xlsx (Microsoft Excel, 10.74 KB) MD5:f8d248734125cce6dedbe84ffeb9dd11 A comparison of values for standards run compared to their official values, from UC Davis Stable Isotope Facility.

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Related Publications

Fuchsman, C. A., & Cram, J. A. (2024). Size fractionated suspended organic carbon and nitrogen from the offshore Eastern Tropical North Pacific Oxygen Deficient Zone suggest contributions of picocyanobacteria and vertically migrating metazoans to organic matter. https://doi.org/10.22541/essoar.173046855.50289201/v1 *Results*

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Related Datasets

IsRelatedTo

University of Maryland Center for Environmental Science. EPR_Size_Fractionated_Microbiota. 2024/11. In: NCBI:BioProject: PRJNA1191024.[Internet]. Bethesda, MD: National Library of Medicine (US), National Center for Biotechnology Information; Available from: http://www.ncbi.nlm.nih.gov/bioproject/PRJNA1191024.

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Parameters

Parameter	Description	Units
Station	station sampled	unitless
latitude	location sampled (latitude)	decimal degrees
longitude	location sampled (longitude)	decimal degrees
Date	date sampled (ISO 8601 format)	unitless
Depth	depth sampled	meters (m)
Size_Fraction	particle size range description (e.g. '> 500', '180 - 500')	micron (um)
d13C_VPDB	isotopic composition of C (d13C). Reference standard VPDB="Vienna Pee Dee Belemnite"	permil (0/00)
d15N_Air	isotopic composition of N (d15N with respect to reference standard air).	permil (0/00)
d15N_BDL_flag	Below Detection Limit 'BDL' flag for the d15N_Air column.	unitless
Carbon	concentration of organic C. Detection limit for C is 30 ug.	micromolar (uM)
Nitrogen	concentration of organic N. Detection limit for N is 5 ug	micromolar (uM)
C_to_N	ratio of molar carbon to nitrogen concentrations (C:N)	unitless
C_to_N_BDL_flag	Below Detection Limit 'BDL' flag for the C:N column "C_to_N"	unitless
Comment	Comment to provide context for missing data. See Problems/Issues section for more details.	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Elementar Vario EL Cube elemental analyzer
Dataset-specific Description	UC Davis Stable Isotope Facility did the C and N analysis utilizing an Elemental Analyzer (Elementar Vario EL Cube) attached to an Isotope Ratio Mass Spectrometer (Isoprim VisION).
Generic Instrument Description	A laboratory instrument used for quantifying organic elements. It can measure C, H, N and S and optionally O, Cl and TIC. It was first developed in 2006 as a successor to the vario EL III. It uses a high-temperature combustion unit that is able to complete sample digestion at up to 1200 deg C (or 1800 deg C at the point of combustion when tin foil is used) and a jet injection of oxygen directly to the sample during combustion. Separation of gas components are performed on up to 3 gas-selective columns which trap gases until they are heated up and the prior gas peak has reached the baseline during detection. It uses a Thermal Conductivity Detector (TCD) as standard. An infrared (IR) detector for sulfur and oxygen and electrochemical detector for chlorine are optionally available. The instrument can measure C / N elemental ratios of up to 12,000:1 and provides an elemental detection limit of < 40 ppm (TCD).

Dataset-specific Instrument Name	
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	UC Davis Stable Isotope Facility did the C and N analysis utilizing an Elemental Analyzer (Elementar Vario EL Cube) attached to an Isotope Ratio Mass Spectrometer (Isoprim VisION).
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

AT42-09

Website	https://www.bco-dmo.org/deployment/937024
Platform	R/V Atlantis
Start Date	2019-03-25
End Date	2019-04-23

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Project Information

Collaborative Research: From hot to cold in the dark - shifts in seafloor massive sulfide microbial communities as physical and geochemical conditions change after venting ceases (Hot2cold Vents)

Coverage: East Pacific Rise

NSF Award Abstract:
Hydrothermal vents, which deposit seafloor massive sulfides (SMS), occur along the 89,000 km of mid-ocean ridges, submarine volcanoes, and backarc basins that occur at tectonic plate boundaries in the ocean. Active hydrothermal vent sulfide chimneys are hotspots of biodiversity and productivity in the deep ocean, as well as potential resources for metals. While significant effort has focused on understanding the diversity of biological communities and geochemistry associated with actively venting SMS, relatively little is known about the biological communities associated with SMS once venting ceases. Furthermore, little is known about the microbiological and geochemical changes that occur during the transition period from active to inactive, during which an important succession occurs in the microbial community and geochemistry of fluids within the chimney. This interdisciplinary project will create and sample this transition period by collecting multiple active SMS samples from individual vents at 9 degrees N East Pacific Rise and allowing them to transition to inactive on the seafloor, mimicking the end of venting while allowing for the exact time when venting ceased to be known, something not possible when sampling naturally formed inactive SMS. Microbial community diversity and metabolism will be analyzed in parallel with bulk and fine-scale geological measurements for active, transitioning, and inactive sulfides. This seafloor experimental and analytical approach will provide knowledge of how microbial communities, rates of biogeochemical transformations, and geological conditions change as SMS transition from hot and actively venting to cold and inactive. Students in grades 6-8 will be entrained into the project through research cruise "ship-to-shore" interactions and communications, post-cruise workshops for educators working with students typically underrepresented in STEM fields, and a collaboration with the Science, Engineering, Art and Design Gallery (SEAD), a community and economic development project in Bryan, TX.

Hydrothermal vents are quantitatively important to the biology and chemistry of the deep ocean, but the vast majority of current knowledge focuses on actively venting deposits. However, after venting ceases, sulfides can persist on the seafloor for tens of thousands of years, making them long-lived, globally-abundant microbial substrates. In recent years, studies of inactive SMS found drastically different microbial communities than those on active deposits, indicating a succession of the microbial community, and thus a potentially different impact on deep ocean biodiversity and biogeochemistry than actively venting deposits. However, ages of the inactive structures are often not known, so it is impossible to estimate how quickly these changes occur, and how quickly co-occurring changes in sulfide mineralogy and microbiological communities occur. This project will provide the first insight into what happens at the microbial and mineralogical level as SMS initially transition from active to inactive. Active SMS will be sampled and analyzed for microbial community composition, functional capacity, gene expression and metabolic rates. Co-located subsamples will be analyzed for porosity and bulk and fine-scale mineralogy. Subsamples of those active SMS samples will be left on the seafloor to incubate and be collected weeks and a year or more later, with the same analyses conducted upon collection. This will allow for determination of microbiological and mineralogical changes that occur during that initial transition and for comparison with older inactive SMS from the same vent fields. Together, the data collected will be integrated to generate a conceptual model of succession of biology, mineralogy, porosity and pore distribution as vent deposits transition from active to inactive. This project will fill a knowledge gap about hydrothermal ecosystems and has the potential to transform the current understanding of diversity and rates of change in these important seafloor biomes.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756339

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