Cellular carbon (C) and nitrogen (N) measurements of marine nitrifiers

Website: https://www.bco-dmo.org/dataset/871075
Data Type: experimental
Version: 1
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Project
» Collaborative Research: Underexplored Connections between Nitrogen and Trace Metal Cycling in Oxygen Minimum Zones Mediated by Metalloenzyme Inventories (CliOMZ)

Contributors	Affiliation	Role
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Abstract
This dataset contains cellular carbon (C) and nitrogen (N) measurements of marine nitrifiers. These data were generated through experiments conducted at the University of California, Santa Barbara over a period of time from March 2018 to August 2021.

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Coverage

Spatial Extent: **Lat**:34.413962 **Lon**:-119.84912
Temporal Extent: 2018-03-12 - 2021-08-20

Methods & Sampling

100-500 mL of culture was filtered onto combusted (450°C, 4h) glass fiber filters (Advantec, GF-75, 25mm). Filters were acidified with HCl (10% v/v), dried (60°C, 24 h), and packed into tin capsules prior to being analyzed on a CHN elemental analyzer (Exeter Analytical, CEC 440HA). The instrument was calibrated with acetanilide following manufacturer protocols.

A detailed description of materials and methods can be found in Bayer et al. 2022.

Data Processing Description

Data Processing:
Cellular carbon (C) content was calculated by dividing total particulate organic C by the number of newly produced cells.

BCO-DMO Processing:
- renamed fields to conform with BCO-DMO naming conventions;
- replaced "NA" with "nd" (no data).

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Data Files

File
nitrifier_cn.csv(Comma Separated Values (.csv), 1.29 KB) MD5:b3e362853af0a2c0ee86293fec8108b9 Primary data file for dataset ID 871075

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Related Publications

Bayer, B., McBeain, K., Carlson, C. A., & Santoro, A. E. (2022). Carbon content, carbon fixation yield and dissolved organic carbon release from diverse marine nitrifiers. https://doi.org/10.1101/2022.01.04.474793
Results

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Parameters

Parameter	Description	Units
Nitrifier_strain	Name of cultured nitrifier	unitless
Growth_phase	Growth phase of the culture when the measurement was taken (EEXP, early exponential growth; LEXP, late exponential growth; STAT, stationary phase)	unitless
Filtered_volume	Culture volume filtered onto glass fiber filter	liters (L)
Blank_corrected_C	Amount of organic carbon corrected for blank (culture medium filtered onto glass fiber filter)	microgram carbon (ug C)
Blank_corrected_N	Amount of nitrogen corrected for blank (culture medium filtered onto glass fiber filter)	microgram nitrogen (ug N)
C_to_N_molar	Molar C:N ratio of biomass	moles of carbon per mole of nitrogen (mol C/mol N)
Cell_abundance	Cell numbers of cultured nitrifiers	cells per liter (cells/L)
C_content	Cellular carbon content	femtogram per cell (fg/cell)

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Instruments

Dataset-specific Instrument Name	CHN elemental analyzer (Exeter Analytical, CEC 440HA)
Generic Instrument Name	CHN Elemental Analyzer
Generic Instrument Description	A CHN Elemental Analyzer is used for the determination of carbon, hydrogen, and nitrogen content in organic and other types of materials, including solids, liquids, volatile, and viscous samples.

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Project Information

Collaborative Research: Underexplored Connections between Nitrogen and Trace Metal Cycling in Oxygen Minimum Zones Mediated by Metalloenzyme Inventories (CliOMZ)

Coverage: Eastern Tropical Pacific

NSF abstract:
Though scarce and largely insoluble, trace metals are key components of sophisticated enzymes (protein molecules that speed up biochemical reactions) involved in biogeochemical cycles in the dark ocean (below 1000m). For example, metalloenzymes are involved in nearly every reaction in the nitrogen cycle. Yet, despite direct connections between trace metal and nitrogen cycles, the relationship between trace metal distributions and biological nitrogen cycling processes in the dark ocean have rarely been explored, likely due to the technical challenges associated with their study. Availability of the autonomous underwater vehicle (AUV) Clio, a sampling platform capable of collecting high-resolution vertical profile samples for biochemical and microbial measurements by large volume filtration of microbial particulate material, has overcome this challenge. Thus, this research project plans an interdisciplinary chemistry, biology, and engineering effort to test the hypothesis that certain chemical reactions, such as nitrite oxidation, could become limited by metal availability within the upper mesopelagic and that trace metal demands for nitrite-oxidizing bacteria may be increased under low oxygen conditions. Broader impacts of this study include the continued development and application of the Clio Biogeochemical AUV as a community resource by developing and testing its high-resolution and adaptive sampling capabilities. In addition, metaproteomic data will be deposited into the recently launched Ocean Protein Portal to allow oceanographers and the metals in biology community to examine the distribution of proteins and metalloenzymes in the ocean. Undergraduate students will be supported by this project at all three institutions, with an effort to recruit minority students. The proposed research will also be synergistic with the goals of early community-building efforts for a potential global scale microbial biogeochemistry program modeled after the success of the GEOTRACES program, provisionally called "Biogeoscapes: Ocean metabolism and nutrient cycles on a changing planet".

The proposed research project will test the following three hypotheses: (1) the microbial metalloenzyme distribution of the mesopelagic is spatially dynamic in response to environmental gradients in oxygen and trace metals, (2) nitrite oxidation in the Eastern Tropical Pacific Ocean can be limited by iron availability in the upper mesopelagic through an inability to complete biosynthesis of the microbial protein nitrite oxidoreductase, and (3) nitrite-oxidizing bacteria increase their metalloenzyme requirements at low oxygen, impacting the distribution of both dissolved and particulate metals within oxygen minimum zones. One of the challenges to characterizing the biogeochemistry of the mesopelagic ocean is an inability to effectively sample it. As a sampling platform, we will use the novel biogeochemical AUV Clio that enables high-resolution vertical profile samples for biochemical and microbial measurements by large volume filtration of microbial particulate material

on a research expedition in the Eastern Tropical Pacific Ocean. Specific research activities will be orchestrated to test the hypotheses. Hypothesis 1 will be explored by comparison of hydrographic, microbial distributions, dissolved and particulate metal data, and metaproteomic results with profile samples collected by Clio. Hypothesis 2 will be tested by incubation experiments using 15NO2- oxidation rates on Clio-collected incubation samples. Hypothesis 3 will be tested by dividing targeted nitrite oxidoreductase protein copies by qPCR (quantitative polymerase chain reaction)-based nitrite oxidizing bacteria abundance (NOB) to determine if cellular copy number varies with oxygen distributions, and by metalloproteomic analyses of NOB cultures. The demonstration of trace metal limitation of remineralization processes, not just primary production, would transform our understanding of the role of metals in biogeochemical cycling and provide new ways with which to interpret sectional data of dissolved and particulate trace metal distributions in the ocean. The idea that oxygen may play a previously underappreciated role in controlling trace metals due not just to metals' physical chemistry, but also from changing biological demand, will improve our ability to predict trace metal distributions in the face of decreasing ocean oxygen content.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1924512

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