Bottle chemistry data from hydrothermal vents sampled by CTD rosette during R/V Atlantis cruise AT37-12 in April and May 2017

Website: https://www.bco-dmo.org/dataset/889539
Data Type: Cruise Results
Version: 1
Version Date: 2023-02-13

Project
» Collaborative Research: Environmental Drivers of Chemoautotrophic Carbon Production at Deep-Sea Hydrothermal Vents - Comparative Roles of Oxygen and Nitrate (vent O2 NO3 roles)

Contributors	Affiliation	Role
Babbin, Andrew R.	Massachusetts Institute of Technology (MIT)	Principal Investigator, Contact
Woosley, Ryan	Massachusetts Institute of Technology (MIT)	Co-Principal Investigator
Cinay, Timur	Massachusetts Institute of Technology (MIT)	Student
Heyl, Taylor	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
The Eastern Tropical North Pacific (ETNP), like the other marine oxygen deficient zones (ODZs), is characterized by an anoxic water column, nitrite accumulation at the anoxic core, and fixed nitrogen loss via nitrite reduction to N2O and N2 gases. Here, we constrain the relative contribution of biogeochemical processes to observable features such as the secondary nitrite maximum (SNM) and local pH maximum by simultaneous measurement of inorganic nitrogen and carbon species. Bottle chemistry data for discrete depths were sampled by CTD rosette from hydrothermal vents in the Eastern Tropical North Pacific during R/V Atlantis cruise AT37-12 in April and May 2017.

Table of Contents

Coverage

Spatial Extent: **N**:14.03 **E**:-90 **S**:9.341 **W**:-104.346
Temporal Extent: 2017-04-25 - 2017-05-12

Methods & Sampling

This dataset represents bottle chemistry (Nitrite, pH, alkalinity, and oxygen) data that were collected from discrete depths by CTD rosette during the AT37-12 cruise on *R/V Atlantis* in the southern part of the Eastern Tropical North Pacific (ETNP) in April–May 2017. Samples were acquired using a 24-bottle CTD rosette equipped with temperature, salinity, pressure, and oxygen sensors at 8 stations. We measured nitrite using the Griess method, Nitrate by chemiluminescence detection via vanadium reduction, pH by colorimetric determination, and Total Alkalinity by titration.

Nitrite was measured using an Ocean Optics QEPRO spectrophotometer with a 10-centimeter Starna flow-through quartz cell. Nitrate is reported as the difference from the total nitrogen oxides measured with a Teledyne T200 NOx analyzer with a custom front end for vanadium reduction and nitrite measurement. pH was measured using an Agilent 8454 spectrophotometer with a custom front end for automated syringe injection. Total Alkalinity was measured using a custom total alkalinity titrator built by the lab of Andrew Dickson at UCSD-Scripps Institute for Oceanography.

Further details in Cinay et al. 2022, Global Biogeochemical Cycles

Data Processing Description

BCO-DMO Processing Description:
- Converted dates to format (YYYY-MM-DD)

[table of contents | back to top]

Data Files

File
bottle_data.csv filename: bottle_data.csv (Comma Separated Values (.csv), 15.23 KB) MD5:5d07dbc711fc1c235c1e804d03bba766 Primary data file for dataset 889539, version 1.

[table of contents | back to top]

Related Publications

Cinay, T., Dumit, D., Woosley, R. J., Boles, E. L., Kwiecinski, J. V., Mullen, S., Tamasi, T. J., Wolf, M. J., Kelly, C. L., Travis, N. M., Casciotti, K. L., & Babbin, A. R. (2022). Coincident Biogenic Nitrite and pH Maxima Arise in the Upper Anoxic Layer in the Eastern Tropical North Pacific. Global Biogeochemical Cycles, 36(12). Portico. https://doi.org/10.1029/2022gb007470 https://doi.org/10.1029/2022GB007470
Results

[table of contents | back to top]

Parameters

Parameter	Description	Units
CRUISEID	Cruise identifier	unitless
STNNBR	Station identifier	unitless
SAMPNO	Sample identifier	unitless
DATE	Date of sampling	unitless
LATITUDE	Latitude of sampling site North (South is negative)	decimal degrees
LONGITUDE	Longitude of sampling site East (West is negative)	decimal degrees
DEPTH	Depth of sampling	dbar
NITRITE	Nitrite concentration	micromoles per liter (umol/L)
NITRATE	Nitrate concentration	micromoles per liter (umol/L)
PH_SWS	pH, seawater scale	unitless
TA	Total alkalinity	micromoles per liter (umol/L)
SIGMA0	Potential density anomaly at sea surface	kilograms per cubic meter

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Custom Alkalinity Titrator
Generic Instrument Name	Automatic titrator
Generic Instrument Description	Instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

Dataset-specific Instrument Name	Teledyne T200 NOx analyzer
Generic Instrument Name	Chemiluminescence NOx Analyzer
Generic Instrument Description	The chemiluminescence method for gas analysis of oxides of nitrogen relies on the measurement of light produced by the gas-phase titration of nitric oxide and ozone. A chemiluminescence analyzer can measure the concentration of NO/NO2/NOX. One example is the Teledyne Model T200: https://www.teledyne-api.com/products/nitrogen-compound-instruments/t200

Dataset-specific Instrument Name	
Generic Instrument Name	CTD - profiler
Generic Instrument Description	The Conductivity, Temperature, Depth (CTD) unit is an integrated instrument package designed to measure the conductivity, temperature, and pressure (depth) of the water column. The instrument is lowered via cable through the water column. It permits scientists to observe the physical properties in real-time via a conducting cable, which is typically connected to a CTD to a deck unit and computer on a ship. The CTD is often configured with additional optional sensors including fluorometers, transmissometers and/or radiometers. It is often combined with a Rosette of water sampling bottles (e.g. Niskin, GO-FLO) for collecting discrete water samples during the cast. This term applies to profiling CTDs. For fixed CTDs, see https://www.bco-dmo.org/instrument/869934.

Dataset-specific Instrument Name	
Generic Instrument Name	Niskin bottle
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

Dataset-specific Instrument Name	Agilent 8454
Generic Instrument Name	Spectrophotometer
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

Dataset-specific Instrument Name	Ocean Optics QEPro
Generic Instrument Name	Spectrophotometer
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

[table of contents | back to top]

Deployments

AT37-12

Website	https://www.bco-dmo.org/deployment/734074
Platform	R/V Atlantis
Report	http://datadocs.bco-dmo.org/docs/Vent_O2_NO3_Roles/data_docs/AT37-12_Cruise_Report.pdf
Start Date	2017-04-24
End Date	2017-05-15

[table of contents | back to top]

Project Information

Collaborative Research: Environmental Drivers of Chemoautotrophic Carbon Production at Deep-Sea Hydrothermal Vents - Comparative Roles of Oxygen and Nitrate (vent O2 NO3 roles)

Coverage: Deep-Sea hydrothermal vent field at 9 deg N on the East Pacific Rise

NSF award abstract:

Deep-sea hydrothermal vents, first discovered in 1977, are exemplary ecosystems where microbial chemosynthesis rather than photosynthesis is the primary source of organic carbon. Chemosynthetic microorganisms use the energy generated by oxidizing reduced inorganic chemicals contained in the vent fluids, like hydrogen sulfide or hydrogen gas, to convert carbon dioxide (CO2) into cell material. By doing so, they effectively transfer the energy from a geothermal source to higher trophic levels, in the process supporting the unique and fascinating ecosystems that are characterized by high productivity - oases in the otherwise barren deep ocean landscape. While the general view of the functioning of these ecosystems is established, there are still major gaps in our understanding of the microbiology and biogeochemistry of these systems. Particularly lacking are studies measuring rates of microbial activity in situ, which is ultimately needed to understand production of these ecosystems and to assess their impact on global biogeochemical cycles. This project makes use of the Vent-Submersible Incubation Device (Vent-SID), a robotic micro-laboratory that was recently developed and tested in the field. This instrument makes it possible for the first time to determine rates of carbon fixation at both in situ pressures and temperatures, revolutionizing the way we conduct microbial biogeochemical investigations at deep-sea hydrothermal vents. This is an interdisciplinary and collaborative effort between two US and foreign institutions, creating unique opportunities for networking and to foster international collaborations. This will also benefit two graduate students working in the project, who will get exposed to a wide range of instrumentation and scientific fields, facilitating their interdisciplinary education. In collaboration with Dr. Nitzan Resnick, academic dean of The Sage School, an elementary school outreach program will be developed and a long-term partnership with the school established. Further, a cruise blog site to disseminate the research to schools and the broader public will be set up. The results will be the topic of media coverage as well as be integrated into coursework and webpages existing either in the PI's labs or at the institution.

This project is using a recently developed robotic micro-laboratory, the Vent-SID, to measure rates of chemoautotrophic production and to determine the relative importance of oxygen and nitrate in driving chemosynthesis at deep-sea hydrothermal vents at in situ pressures and temperatures and to tackle the following currently unresolved science objectives: 1) obtain in situ rates of chemoautotrophic carbon fixation, 2) obtain in situ nitrate reduction rate measurements, and 3) directly correlate the measurement of these processes with the expression of key genes involved in carbon and energy metabolism. Although recent data suggests that nitrate reduction either to N2 (denitrification) or to NH4+ (dissimilatory reduction of nitrate to ammonium) might be responsible for a significant fraction of chemoautotrophic production, NO3-reduction rates have never been measured in situ at hydrothermal vents. The researchers hypothesize that chemoautrophic growth is strongly coupled to nitrate respiration in vent microbial communities. During a cruise that will take place approximately 12 months into the project (~Feb 2017), the researchers will carry out a total of 4 deployments of the Vent-SID as well as ancillary sampling collection at the 9°46N to 9°53N segment of the East Pacific Rise. They will focus efforts on two diffuse-flow vent sites, "Crab Spa" and "Teddy Bear". "Crab Spa" is a diffuse flow vent site (T: 25°C) that has been used as a model system to gain insights into chemoautotrophic processes and has been frequently sampled over the last several years. This vent site has been very well characterized, both geochemically and microbiologically, providing excellent background data for

the proposed process oriented studies. "Teddy Bear" is a diffuse-flow site that was discovered in Jan 2014, and it has a lower temperature (T: 12°C), making it a good comparative site. The researchers will perform a number of short duration time-course incubations to assess the role of different environmental parameters that have been identified as likely key variables (e.g., O2, temperature, NO3-), and to link these process rate measurements to the expression of functional genes using metatranscriptomic analyses. This study will be the first attempt to measure critical metabolic processes of hydrothermal vent microbial assemblages under critical in situ conditions and to assess the quantitative importance of electron donor and acceptor pathways in situ. In the future, it is envisioned that the Vent-SID will become a routine application by the oceanographic community for measuring time series rates of relevant metabolic processes at hydrothermal vents under in situ pressures and vent fluid temperatures.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1559198
NSF Division of Ocean Sciences (NSF OCE)	OCE-1559042

[table of contents | back to top]