Maximum rates of microbially mediated sulfate reduction from three hydrothermal vents along the Juan de Fuca Ridge from R/V Atlantis cruise AT15-67 in the Juan de Fuca Ridge in 2010

Website: https://www.bco-dmo.org/dataset/626302
Version: 13 November 2015
Version Date: 2015-11-13

Project
» Characterizing the distribution and rates of microbial sulfate reduction at Middle Valley hydrothermal vents (Middle Valley Vents)

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

Contributors	Affiliation	Role
Girguis, Peter	Harvard University	Principal Investigator
Frank, Kiana	University of Hawai'i at Mānoa (SOEST)	Contact
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Table of Contents

- Dataset Description
  - Methods & Sampling
  - Data Processing Description
- Data Files
- Parameters
- Instruments
- Deployments
- Project Information
- Program Information
- Funding

Dataset Description

Maximum rates of microbially mediated sulfate reduction from three distinct hydrothermal vents in the Middle Valley vent field along the Juan de Fuca Ridge. Samples were recovered from actively venting sulfide deposits at Needles (48.45778, -128.709), Dead Dog (48.45603,-128.71), and Chowder Hill (48.455543, -128.709) vents.

Analysis and write up of these data can be found at:
Frank, K.L., Rogers, D. R., Olins, H. C., Vidoudez, C., & Girguis, P. R. 2013. Characterizing the distribution and rates of microbial sulfate reduction at Middle Valley hydrothermal vents. The ISME journal, 7, 1391–1401. doi:10.1038/ismej.2013.17

Methods & Sampling

Sampling and Analytical Methodology: Once on board ship, samples were directly transferred to sterile anaerobic
seawater and handled/processed using appropriate sterile microbiological techniques. Subsamples were immediately transferred to gastight jars (Freund Container Inc.), filled with sterile anaerobic seawater containing 2 mM sodium sulfide at pH 6, and stored at 4 degrees C. Upon return to the laboratory, all samples were maintained in anaerobic seawater
(0.2 um filter-sterilized prior to use) supplemented with 2mM ΣH2S (defined as the sum of H2S, HS- and S2-) and adjusted to pH 6. The vent-like media was replenished every 8 to 12 weeks, and all samples were kept in the dark and 4 degrees C prior to incubation. Hydrothermal deposits were homogenized in a commercial

blender (Xtreme™
blender, Waring Inc.) under a nitrogen atmosphere. Anaerobic homogenization was designed to minimize fine-scale geochemical and microbial heterogeneity and facilitate more accurate experimental replication. Hydrothermal homogenate (made up of both mineral deposit and interstitial fluid)) was aliquoted volumetrically (7.5 mL, ca. 29 g wet weight and ca. 20 g dry weight) into Balch tubes in an anaerobic chamber. The tubes were supplemented with 15 mL of sterile artificial vent fluid media designed to mimic the geochemical composition of fluids within the pores of a sulfide deposit (pH 6, 14 mM SO42-, 2.3 mM NaHCO3, 1 mM H2S, and 10 uM each of pyruvate, citrate, formate, acetate, lactate). Organic acid concentrations are comparable to those measured in situ along the Juan de Fuca ridge (Lang et al. 2006). Sufficient 35SO42- was added to achieve 555 kBq (15 uCi) of activity. Due to technical difficulties with post processing methodology, shipboard incubations using fresh material were not successful. The data presented here were generated using samples that had been maintained in sulfidic ventlike effluent (as described above) for one year. Samples were incubated anaerobically for 7 days at 4, 30, 40, 50, 60, 80 and 90 degrees C. Controls for sulfate reduction consisted of samples amended with 28 mM molybdate, a competitive inhibitor of sulfate reduction (Saleh et al. 1964; Newport & Nedwell, 1988). Six biological replicates were run for each treatment, and three biological replicates for each control. Upon completion, reactions were quenched with the injection of 5 mL 25% zinc acetate (which is ~20-fold more Zinc than the maximum sulfide concentration), and all samples were frozen at -20 degrees C to enable further analysis.

1 gram (wet weight) of crushed mineral (about 60% mineral, 30% interstitial fluid) was added to 10 mL of a 1:1 ethanol to water solution in the chromium distillation apparatus, and then degassed with nitrogen for 15 minutes to achieve anaerobicity. 8 mL of 12 N HCl and 16 mL of 1 M reduced chromium chloride was added anaerobically to the chamber and gently heated to a slow boil for 3 hours to evolve hydrogen sulfide gas. The resulting sulfide gas was carried via nitrogen gas through a condenser to remove any ethanol or water vapor, and was then trapped as zinc sulfide in a 25% zinc acetate solution. The radioactivity of the resulting sulfide (Zn35S) and the remaining sulfate from the supernatant (35SO42-) were measured via liquid scintillation counter in Ultima Gold scintillation cocktail (ThermoFisher Inc., Waltham, MA).

Data Processing Description

Data Processing: Sulfate reduction rates (SRR) were calculated as in (Fossing & Jorgensen, 1989) using the following calculation:

SRR = (nSO42- * a * 1.06) / ((a + A) * t)

Where nSO42- is the quantity (in moles) of sulfate added to each incubation (14 mM * 15 mL = 210 umol), a is the activity (dpm) of the trapped sulfide, 1.06 is the fractionation factor between the sulfide and sulfate pools, A is the activity of the sulfate pool at the completion of the incubation and t is the incubation time (days). The rates are presented in units of nmol S g-1 day-1.

[table of contents | back to top]

Data Files

File
MV_SRR.csv (Comma Separated Values (.csv), 1.20 KB) MD5:66ad131a9f90aba0a72aa66323c63dfb Primary data file for dataset ID 626302

[table of contents | back to top]

Parameters

Parameter	Description	Units
sample	Sample name.	dimensionless
lat	Latitude of sampling site. Positive values = North.	decimal degrees
lon	Longitude of sampling site. Positive values = East.	decimal degrees
depth	Depth from which sample was obtained.	meters
Tmax	Maximum temperature at the sampling site.	degrees Celsius
temp	Temperature at which samples were incubated.	degrees Celsius
rate_sevday	Sulfate Reduction Rate over 7 day incubation.	nanomoles Sulfur per gram per day (nmol S g-1 day-1)
rate_svday_stdev	Standard deviation of rate_sevday.	nanomoles Sulfur per gram per day (nmol S g-1 day-1)
replicates_rate_sevday	Number of replicates.	dimensionless
rate_inhib	Sulfate Reduction Rate of molybdate amended incubations (negative control).	nanomoles Sulfur per gram per day (nmol S g-1 day-1)
rate_inhib_stdev	Standard deviation of rate_inhib.	nanomoles Sulfur per gram per day (nmol S g-1 day-1)
replicates_rate_inhib	Number of replicates.	dimensionless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	liquid scintillation counter
Generic Instrument Name	Liquid Scintillation Counter
Dataset-specific Description	The radioactivity of the Zn35S and the remaining sulfate from the supernatant (35SO42-) were measured via liquid scintillation counter in Ultima Gold scintillation cocktail (ThermoFisher Inc., Waltham, MA).
Generic Instrument Description	Liquid scintillation counting is an analytical technique which is defined by the incorporation of the radiolabeled analyte into uniform distribution with a liquid chemical medium capable of converting the kinetic energy of nuclear emissions into light energy. Although the liquid scintillation counter is a sophisticated laboratory counting system used the quantify the activity of particulate emitting (ß and a) radioactive samples, it can also detect the auger electrons emitted from 51Cr and 125I samples. Liquid scintillation counters are instruments assaying alpha and beta radiation by quantitative detection of visible light produced by the passage of rays or particles through a suitable scintillant incorporated into the sample.

[table of contents | back to top]

Deployments

AT15-67

Website	https://www.bco-dmo.org/deployment/626312
Platform	R/V Atlantis
Start Date	2010-07-06
End Date	2010-07-26

[table of contents | back to top]

Project Information

Characterizing the distribution and rates of microbial sulfate reduction at Middle Valley hydrothermal vents (Middle Valley Vents)

Coverage: Middle Valley vent field along the Juan de Fuca Ridge

This project characterizes rates of microbially mediated sulfate reduction from three distinct hydrothermal vents in the Middle Valley vent field along the Juan de Fuca Ridge, as well as assessments of bacterial and archaeal diversity, estimates of total biomass and the abundance of functional genes related to sulfate reduction, and in situ geochemistry. Maximum rates of sulfate reduction occurred at 90°C in all three deposits. Pyrosequencing and functional gene abundance data reveal differences in both biomass and community composition among sites, including differences in the abundance of known sulfate reducing bacteria. The abundance of sequences for Thermodesulfovibro-like organisms and higher sulfate reduction rates at elevated temperatures, suggests that Thermodesulfovibro-like organisms may play a role in sulfate reduction in warmer environments. The rates of sulfate reduction observed suggest that - within anaerobic niches of hydrothermal deposits - heterotrophic sulfate reduction may be quite common and might contribute substantially to secondary productivity, underscoring the potential role of this process in both sulfur and carbon cycling at vents.

This project was funded, in part, by a C-DEBI Graduate Student Fellowship.

[table of contents | back to top]

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1061934
NSF Division of Ocean Sciences (NSF OCE)	OCE-0838107
NASA Astrobiology Science & Technology for Exploring Planets (NASA-ASTEP)	NNX09AB78G
NASA Astrobiology Science & Technology for Exploring Planets (NASA-ASTEP)	NNX07AV51G

[table of contents | back to top]