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

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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
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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. 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 column9.85°N 104.30°W Depth profile

Dataset Description

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

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.

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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Parameters

Parameters for this dataset have not yet been identified

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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
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