Phosphate redox data from cruise AE1409 from R/V Atlantic Explorer AE1409 in the Western Tropical North Atlantic from May 2014 (P Processing by Tricho project)

Website: https://www.bco-dmo.org/dataset/709104
Data Type: Cruise Results
Version: 1
Version Date: 2017-07-14

Project
» Dissolved Phosphorus Processing by Trichodesmium Consortia: Quantitative Partitioning, Role of Microbial Coordination, and Impact on Nitrogen Fixation (P Processing by Tricho)

Contributors	Affiliation	Role
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Abstract
Phosphate redox data from cruise AE1409 from R/V Atlantic Explorer AE1409 in the Western Tropical North Atlantic from May 2014 (P Processing by Tricho project). Sampling was conducted aboard the R/V Atlantic Explorer during a cruise in May of 2014. Water samples for whole community analyses were collected from Niskin bottles deployed on a rosette with a CTD.

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Coverage

Spatial Extent: **N**:23.0313 **E**:-57.27 **S**:12.0313 **W**:-64.985
Temporal Extent: 2014-05-12 - 2014-05-27

Dataset Description

Phosphate redox data from cruise AE1409.

Methods & Sampling

All data collected as described in Van Mooy et al (2015).

Sampling - Sampling was conducted aboard the R/V Atlantic Explorer during a cruise in May of 2014. Water samples for whole community analyses were collected from Niskin bottles deployed on a rosette with a CTD.

Samples were taken at depths of 5m, 40m, and 150m. Subsamples for incubations were dispensed from the Niskin bottle directly into triplicate acid-cleaned 30 mL polycarbonate bottles and processed as described below. Trichodesmium colonies were collected from the near surface (approximately the top 25 m) using a handheld 130 um net. Single colonies were visually identified, picked with a pipette and transferred into 0.2 um-filtered local surface water, collected at 5m with a Niskin bottle as described above. Trichodesmium colonies were serially transferred three times into fresh 0.2 um-filtered local surface water to reduce the presence of other microbes in the samples. Shipboard microscopic analyses suggested this removed all but the epibiotic cells that were tightly-associated with the colonies themselves. Between 10 and 15 washed Trichodesmium colonies each were then transferred into triplicate 60 mL acid-cleaned polycarbonate bottles filled with 30 mL of 0.2 um-filtered local surface seawater for further analyses. Although the colony number used for the assay varied between stations, the colony number for each replicate sampled at a given station was the same. In all cases similar sized colonies were used and approximately, 90% of the colonies in each bottle represented the “raft” morphology (colonies with a parallel organization of trichomes), and 10% of the colonies represented the “puff” morphology (radial organization of the trichomes), mimicking the morphology ratio observed in situ.

Phosphate uptake rates - The incubation bottles were carried to a laboratory van that was designated solely for work with radioactive isotopes. Each incubation bottle was spiked with approximately 1.5 uCi of 33P-phosphoric acid. The final concentration of 33P-phosphate in the incubations was approximately 6 pmol L-1, which was likely approximately two orders of magnitude smaller than ambient phosphate concentrations. The bottles were capped and mixed by gently inverting. At each station, three incubations were dedicated to measuring 33P-phosphate uptake and three incubations were dedicated to measuring the chemical reduction of 33P-phosphate to P(III) compounds. The bottles were placed in a flow-through on-deck incubator that was maintained at surface seawater temperatures by continually flushing with the surface seawater from the ship’s pumping system. Temperature in the incubators was occasionally monitored with a waterproof temperature logger (Onset), and found to be within 1 C of surface water temperature. The incubators used a combination of neutral density screening and blue transparent film to achieve a light intensity of mimicking PAR at roughly 20m, as confirmed using an underwater spherical quantum sensor (Li-Cor). At three occasions during the cruise (Stations 2, 4, and 9), an additional set of triplicate incubations for each measurement were terminated immediately (i.e. prior to incubation) and processed identically to the experimental incubations; data from these incubations were used to quantify background 33P signals in all of our measurements (i.e. analytical blanks). Background 33P was consistent at all three stations, and was averaged and then subtracted from all of the experimental results; the standard deviation of the background was propagated as analytical error. In all cases the 33P radioactivity recovered from the experimental incubations was three times greater than the background 33P radioactivity. Incubations proceeded for an average of 3.25 h before being terminated by vacuum (approximately 200 mbar) filtration on 25 mm diameter polycarbonate membranes (Millipore); a poresize of 0.2 um was used for whole community incubations and a poresize of 5.0 um was used for the Trichodesmium incubations. The membranes were quickly rinsed three times with freshly filtered (0.2 um poresize polycarbonate membrane) surface seawater. The membranes were then immediately placed in a liquid scintillation vial containing 10 mL of UltimaGold liquid (Perkin Elmer) scintillation cocktail, which was then shaken vigorously. After resting for a few hours, the 33P-radioacitivity in the vials was determined using a liquid scintillation counter (Perkin Elmer). A steady-state phosphate turnover rate was calculated by dividing the total 33P radioactivity retained on the membranes by the total 33P radioactivity added to the incubations and the incubation time. Turnover times (reciprocal of turnover rates) varied from between 15 and 50 hours (not shown), which is much longer than the incubation time and validates the steady-state calculation.

Phosphate reduction to intracellular P(III) compounds - Incubations were terminated by vacuum filtration as described above. Next, the membranes were immersed in 2.0 mL of sterile Milli-Q water in a cryovial (Fisher). The vials were immediately capped and immersed in liquid nitrogen for approximately 10 min, before they were immersed in boiling-hot water for 10 min, and then vigorously shaken. This freeze-thaw cycle was repeated two additional times, after which generally little discernable cellular debris was visible. Next, the 2.0 mL sample, which now contained intercellular biochemicals released during the freeze/thaw/shake cycles, was placed in a 5 mL syringe. The sample was then spiked with 5 uL of 1 g L-1 standard solution of non-33P-labeled sodium phosphite as a carrier and recovery standard. The contents of the syringe were gently pushed through a 0.2 um poresize nylon membrane to remove cell debris, a Dionex OnGuard II Na (Thermo) cartridge to remove magnesium ions, and a Dionex OnGuard II Ba/Ag/H cartridge to remove chloride ions; cell debris, magnesium ions, and chloride ions all have the potential interfere with ion-exchange chromatography (IC) method we employed. Next, 250 uL aliquots of the samples were injected on a IC system (Dionex) which pumped an eluent of 15 mmol L-1 sodium hydroxide through an IonPac AS15 (Dionex) column at a rate of 1.2 mL min-1. An ion suppressor using Milli-Q water as a regenerant removed sodium hydroxide from the eluent. The retention time of phosphite was monitored by conductivity using an ED40 electrochemical detector (Dionex); this information was used to make fine adjustments to the time intervals that eluent fractions were collected. Fractions corresponding to one minute before and after the leading edge of the phosphite peak were collected directly into scintillation vials using an autosampler (Gilson) and the 33P-radioactivity determined as described above.

The 33P-radioactivity of the two fractions was summed, corrected for dilution, and then divided by the average 33P-radioactivity from the parallel 33P-phosphate uptake incubations to determine the fraction (%) of 33P uptake that was incorporated into P (III) compounds. The standard deviation of the 33P-uptake was propagated as analytical error (in addition to error from the blank subtraction described above). All samples were processed at sea in May 2014 except samples from Station 19, which were snap-frozen in liquid nitrogen, transported to the laboratory in a cryogenic dry shipper, and stored in liquid nitrogen until their analysis in August 2014.

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Data Files

File
P_redox.csv (Comma Separated Values (.csv), 2.19 KB) MD5:5a817a795b2a1f8a8ffda9f3b5e48729 Primary data file for dataset ID 709104

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Related Publications

Frischkorn, K. R., Rouco, M., Van Mooy, B. A. S., & Dyhrman, S. T. (2017). Epibionts dominate metabolic functional potential of Trichodesmium colonies from the oligotrophic ocean. The ISME Journal, 11(9), 2090–2101. doi:10.1038/ismej.2017.74
General

Van Mooy, B. A. S., Krupke, A., Dyhrman, S. T., Fredricks, H. F., Frischkorn, K. R., Ossolinski, J. E., … Sylva, S. P. (2015). Major role of planktonic phosphate reduction in the marine phosphorus redox cycle. Science, 348(6236), 783–785. doi:10.1126/science.aaa8181
Methods

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Parameters

Parameter	Description	Units
Station	Numeric identifier for the station where the data was collected.	unitless
Sample_type	Text description of type of sample collected.	unitless
Depth	Depth at which the sample was collected.	meters
P33_P04_incorp_into_P_III_comps	P33 phosphate incorporation into P(III) compounds.	counts per minute per liter hour (cpm/(L h))
P33_PO4_uptake	P33 phosphate uptake.	counts per minute per liter hour (cpm/(L h))
P33_P04_incorp_into_P_III_comps_pcnt	Percent P33 phosphate incorporation into P(III) compounds.	unitless
P33_P04_incorp_into_P_III_comps_error_pcnt	Analytical error percent of P33 phosphate incorporation into P(III) compounds.	unitless
Lat	Latitude of sampling. Positive values indicate North.	Decimal Degrees
Long	Longitude of sampling. Negative values indicate West.	Decimal Degrees
Date	Sampling date formatted as YYYYMMDD.	YYYYMMDD

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Instruments

Dataset-specific Instrument Name	Dionex ED40 electrochemical detector
Generic Instrument Name	Conductivity Meter
Dataset-specific Description	The retention time of phosphite was monitored by conductivity using an ED40 electrochemical detector (Dionex).
Generic Instrument Description	Conductivity Meter - An electrical conductivity meter (EC meter) measures the electrical conductivity in a solution. Commonly used in hydroponics, aquaculture and freshwater systems to monitor the amount of nutrients, salts or impurities in the water.

Dataset-specific Instrument Name	handheld 130 µm net
Generic Instrument Name	Hand-held plankton net
Dataset-specific Description	Trichodesmium colonies were collected from the near surface (approximately the top 25 m) using a handheld 130 µm net.
Generic Instrument Description	A Hand-held plankton net is a fine-meshed net designed for sampling microzooplankton, mesozooplankton or nekton.

Dataset-specific Instrument Name	flow-through on-deck incubator
Generic Instrument Name	In-situ incubator
Dataset-specific Description	Flow-through on-deck incubator was maintained at surface seawater temperatures by continually flushing with the surface seawater from the ship’s pumping system.
Generic Instrument Description	A device on a ship or in the laboratory that holds water samples under controlled conditions of temperature and possibly illumination.

Dataset-specific Instrument Name	underwater spherical quantum sensor (Li-Cor)
Generic Instrument Name	LI-COR Biospherical PAR Sensor
Dataset-specific Description	The incubators used a combination of neutral density screening and blue transparent film to achieve a light intensity of mimicking PAR at roughly 20m, as confirmed using an underwater spherical quantum sensor (Li-Cor).
Generic Instrument Description	The LI-COR Biospherical PAR Sensor is used to measure Photosynthetically Available Radiation (PAR) in the water column. This instrument designation is used when specific make and model are not known.

Dataset-specific Instrument Name	liquid scintillation counter (Perkin Elmer)
Generic Instrument Name	Liquid Scintillation Counter
Dataset-specific Description	The 33P-radioacitivity in the vials was determined using a liquid scintillation counter (Perkin Elmer).
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.

Dataset-specific Instrument Name	Niskin bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Water samples for whole community analyses were collected from Niskin bottles deployed on a rosette with a CTD.
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	temperature logger (Onset)
Generic Instrument Name	Water Temperature Sensor
Dataset-specific Description	Temperature in the incubators was occasionally monitored with a waterproof temperature logger (Onset).
Generic Instrument Description	General term for an instrument that measures the temperature of the water with which it is in contact (thermometer).

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Deployments

AE1409

Website	https://www.bco-dmo.org/deployment/565190
Platform	R/V Atlantic Explorer
Start Date	2014-05-08
End Date	2014-05-26
Description	May 2014 cruise conducted as part of the "Dissolved Phosphorus Processing by Trichodesmium Consortia: Quantitative Partitioning, Role of Microbial Coordination, and Impact on Nitrogen Fixation" project.

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Project Information

Dissolved Phosphorus Processing by Trichodesmium Consortia: Quantitative Partitioning, Role of Microbial Coordination, and Impact on Nitrogen Fixation (P Processing by Tricho)

Coverage: Western Tropical North Atlantic

Description from NSF award abstract:
Colonies of the cyanbacterium *Trichodesmium* are responsible for a large fraction of N2 fixation in nutrient-poor, open-ocean ecosystems, ultimately fueling primary production in both *Trichodesmium* and in the broader planktonic community. However, in some parts of the ocean, the scarcity of dissolved phosphorus limits rates of *Trichodesmium* N2 fixation. *Trichodesmium* colonies employ an arsenal of strategies to mitigate the effects of phosphorus limitation, and the consortia of epibiotic bacteria in the colonies may play a significant role in phosphorus acquisition.

In this study, researchers from Woods Hole Oceanographic Institution and Columbia University will use metagenomic and metatranscriptomic sequencing to investigate how phosphorus metabolism is coordinated in *Trichodesmium* consortia, and to discern the role of quorum sensing in phosphorus acquisition and partitioning. Results from this study are expected to expand understanding of *Trichodesmium* from a monospecific colony whose primary function is fixing CO2 and N2 toward a unique planktonic consortium with a diverse, complex, and highly coordinated overall metabolism that exerts profound control over the cycling of inorganic and organic nutrients in the oligotrophic upper ocean.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1332898
NSF Division of Ocean Sciences (NSF OCE)	OCE-1332912

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