Concentrations of soluble reactive phosphate in treatments amended with dissolved organic phosphate compounds in bioassay experiments (incubation 48h) with seawater from R/V Savannah cruise SAV-19-02 in the NW Atlantic Ocean in Spring of 2019

Website: https://www.bco-dmo.org/dataset/864236
Data Type: Cruise Results, experimental
Version: 1
Version Date: 2021-11-02

Project
» Collaborative Research: Assessing the role of compound-specific phosphorus hydrolase transformations in the marine phosphorus cycle (P-hydrolase)

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Abstract
Concentrations of soluble reactive phosphate in treatments amended with dissolved organic phosphate compounds, over an incubation period of 48 h during bioassay experiments with seawater collected during R/V Savannah cruise SAV-19-02 from March to April of 2019 in the Northwestern Atlantic from the surface to 50 m depth.

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Coverage

Spatial Extent: **N**:31.7635 **E**:-79.8421 **S**:31.0175 **W**:-80.7965
Temporal Extent: 2019-03-30 - 2019-04-10

Methods & Sampling

Sampling and analytical procedures:

Bioassay experiments were conducted at station 1 and stations 3. At each station, inorganic and organic phosphate amendments were performed on seawater with and without nitrogen enrichment (NH4Cl, NaNO3). Bioassay Experiments consisted in incubating, over an incubation period of 48h, surface seawater (5m) with inorganic or organic phosphate compounds (20 µM; final concentration of P) including, polyphosphate (polyp), inorganic phosphate (Pi), nucleotides (ATP or AMP) and methylphosphonate (Mepn). In each incubation

experiment, a control treatment (surface seawater without amendment) was included.

To investigate a potential abiotic hydrolysis of inorganic and organic phosphate compounds, duplicates of surface seawater sampled inshore (5 m) and previously autoclaved (120°C; 30 min), were incubated in parallel. The autoclaved seawater (1L) was amended with either Mepn, AMP, ATP or PolyP (final concentration 20 µM P).

In bioassay experiments, subsamples (50 mL) were taken for SRP determination from each experimental incubation bottle and then filtered through pre-combusted (450°C, 4.5 h) and acid washed (1N HCl) GF/F filter using a syringe (25 mm). The filtrates were then transferred into acid cleaned (10% HCl) HDPE bottles (60 mL) and kept frozen until analysis. SRP concentrations were analyzed following a spectrophotometric method based on the molybdenum reagent (Murphy and Riley, 1962). SRP concentrations (all samples except Pi amended treatments and T=48h of AMP and ATP amended treatments) were analyzed using the Liquid Waveguide Capillary Cell® (LWCC, optical length path=2.5 m). Pi amended treatments as well as T=48h of AMP and ATP amended treatments were analyzed using a conventional spectrophotometer (Genesys®) with a 10 cm cuvette.

Instruments: Measurements of SRP were performed using the Liquid wave guide capillary cell (2.5 m length path, model 3250, World Precision Instrument) and using a conventional spectrophotometer (Genesys®,10 cm cuvette).

Location: Northwestern Atlantic surface waters. Depth: surface-50 m.

Data Processing Description

Data were organized using MATLAB and output as .mat files. Gaps in data were filled with NaN in the .mat files.

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Related Publications

Murphy, J., & Riley, J. P. (1962). A modified single solution method for the determination of phosphate in natural waters. Analytica Chimica Acta, 27, 31–36. doi:10.1016/s0003-2670(00)88444-5
https://doi.org/10.1016/S0003-2670(00)88444-5
Methods

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	Liquid wave guide capillary cell (2.5 m length path, model 3250, World Precision Instrument)
Generic Instrument Name	Liquid Waveguide Capillary Cells
Dataset-specific Description	Measurements of SRP were performed using the Liquid wave guide capillary cell (2.5 m length path, model 3250, World Precision Instrument) and using a conventional spectrophotometer (Genesys®,10 cm cuvette).
Generic Instrument Description	Liquid Waveguide Capillary Cells (LWCC) are optical sample cells that combine an increased optical pathlength (2-500 cm) with small sample volumes. They can be connected via optical fibers to a spectrophotometer with fiber optic capabilities. Similar to optical fibers, light is confined within the (liquid) core of an LWCC by total internal reflection at the core/wall interface. Ultra-sensitive absorbance measurements can be performed in the ultraviolet (UV), visible (VIS) and near-infrared (NIR) to detect low sample concentrations in a laboratory or process control environment. According to Beer's Law the absorbance signal is proportional to chemical concentration and light path length.

Dataset-specific Instrument Name	Genesys®,10 cm cuvette
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	Measurements of SRP were performed using the Liquid wave guide capillary cell (2.5 m length path, model 3250, World Precision Instrument) and using a conventional spectrophotometer (Genesys®,10 cm cuvette).
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.

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Deployments

SAV-19-02

Website	https://www.bco-dmo.org/deployment/864191
Platform	R/V Savannah
Start Date	2019-03-30
End Date	2019-04-11
Description	Cruise synonym: Zephyr (Zooming in on Enzymatic PhosphoHYdrolysis Reactions)

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Project Information

Collaborative Research: Assessing the role of compound-specific phosphorus hydrolase transformations in the marine phosphorus cycle (P-hydrolase)

NSF Award Abstract:
Phosphorus (P) is an essential building block for life. Because P is in short supply over vast areas of the ocean, P availability may control biological productivity, such as photosynthesis and carbon fixation, which has implications for uptake of the greenhouse gas carbon dioxide and thus climate regulation. Marine microorganisms must satisfy their nutritional requirement for P by obtaining it from seawater, where P is present in a variety of chemical forms, from simple phosphate ions (Pi) to complex dissolved organic phosphorus (DOP) molecules. The concentration of DOP vastly exceeds Pi over most ocean areas, therefore DOP is a critically important source of P for marine microbial nutrition and productivity. However, much remains unknown about the contribution of specific DOP compounds to the P nutrition, productivity, and structure of marine microbial communities. In this project, the investigators will conduct field experiments in the Atlantic Ocean and perform a series of controlled laboratory studies with pure enzymes and microbial cultures to determine how and to what extent different DOP compounds are degraded to Pi in the marine environment. Furthermore, the contribution of these compound-specific DOP molecules to microbial P nutrition, carbon fixation, and community structure will be determined, thus advancing the current state of knowledge regarding the factors that control the activity and distribution of microbial species in the ocean, and the ocean?s role in the climate system. This project will support two female junior investigators, a postdoctoral researcher, and graduate and undergraduate students. The undergraduate students will be recruited from the Marine Sciences program at Savannah State University, an Historically Black Colleges and Universities. In addition, results will be incorporated into new hands-on K-12 educational tools to teach students about microbial P biogeochemistry, including a digital game and formal lesson plans with hands-on demos. These tools will be validated with K-12 educators and will be widely accessible to the public through various well-known online platforms. These activities will thus reach a broad audience including a significant fraction of underrepresented groups.

P is a vital nutrient for life. Marine microorganisms utilize P-hydrolases, such as alkaline phosphatase (AP), to release and acquire phosphate (Pi) from a wide diversity of dissolved organic P (DOP) compounds, including P-esters (P-O-C bonds), phosphonates (P-C), and polyphosphates (P-O-P). Compound-specific DOP transformations have the potential to exert critical and wide-ranging impacts on marine microbial ecology (e.g. variable DOP bioavailability among species), biogeochemistry (e.g. P geologic sequestration via formation of calcium Pi), and global climate (e.g. aerobic production of the greenhouse gas methane by dephosphorylation of methylphosphonate). However, the mechanisms and comparative magnitude of specific DOP transformations, in addition to their relative contributions to microbial community-level P demand, productivity, and structure, are not completely understood. This study will fill these knowledge gaps by tracking the fate of specific DOP pools in the marine environment. Specifically, this project will test four hypotheses in the laboratory using recombinant enzymes and axenic cultures representative of marine eukaryotic and prokaryotic plankton from high and low nutrient environments, and in the field using observational and experimental approaches along natural Pi gradients in the Atlantic Ocean. In particular, the investigators will reveal potential differences in the hydrolysis and utilization of specific DOP compounds at the community- (bulk enzymatic assays), taxon- (cell sorting of radiolabeled cells in natural samples), species- (axenic cultures) and molecular-levels (pure enzyme kinetic studies and cell-associated proteomes and exoproteomes). Results from our proposed work will provide a robust understanding of the enzymatic basis involved in the transformation of specific forms of DOP and create new knowledge on the relative contribution of these specific P sources to Pi production, marine microbial nutrition, community structure, primary productivity, and thus global carbon cycling and climate. In particular, our refined measurements of the concentration of bioavailable DOP and our unique estimates of DOP remineralization fluxes will provide critical new information to improve models of marine primary production and P cycling.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1736967
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NSF Division of Ocean Sciences (NSF OCE)	OCE-2001212
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