Concentrations of particulate phosphate in seawater collected during R/V Savannah cruise SAV-19-02 in the NW Atlantic Ocean in the Spring of 2019

Website: https://www.bco-dmo.org/dataset/864291
Data Type: Cruise Results
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Project
» Collaborative Research: Assessing the role of compound-specific phosphorus hydrolase transformations in the marine phosphorus cycle (P-hydrolase)

Contributors	Affiliation	Role
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Abstract
Concentrations of particulate phosphate in 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:

Seawater samples were collected in triplicate from Niskin bottles (12 L), at three stations (St. 1, St. 2 and St. 3) along a transect from coastal Georgia to offshore waters. Latitude (lat) and longitude (lon) of sampling sites are provided in .mat files. Stations 1 and 2 were on the continental shelf (15–30 m depth), while Station 3 was on the shelf break (220 m depth) adjacent to the Gulf Stream. At each station, samples were collected at 2-3 depths between the surface (4–5 m) and 50 m for SRP, DOP and PP. SRP (50 mL), DOP (50 mL) and PP (2 L) were sampled from Niskin bottles. SRP and DOP samples were filtered through 0.2 µm polycarbonate filters and transferred into high density polyethylene bottles (HDPE, 60 mL) and kept frozen (-20°C) until analysis. PP samples were filtered through pre-combusted (450°C, 4.5h) and acid washed (1N HCl) GF/F filters, using a peristaltic pump. PP filters were wrapped in pre-combusted (450°C, 4.5h) aluminum foil, and kept frozen (-20°C) until analysis.

SRP, DOP and PP were analyzed following a spectrophotometric method based on the molybdenum reagent (Murphy and Riley, 1962). SRP concentrations were analyzed using the Liquid Waveguide Capillary Cell® (LWCC, optical length path = 2.5 m). DOP concentrations were determined by subtraction of SRP from the total dissolved phosphate (TDP). TDP was digested to SRP following the wet oxidation procedure (Pujo-Pay and Raimbault, 1994) and SRP was subsequently determined using the LWCC. PP concentrations were determined after high-temperature combustion (450°C, 4.5 h) and HCl extraction (0.5 N) (Strickland and Parsons, 1972). The released SRP following this procedure was then analyzed spectrophotometrically using a conventional spectrophotometer with a 10 cm cuvette.

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

Instruments: Sampling was performed using Niskin bottles (12 L) mounted on a rosette. Measurements of SRP, DOP were performed using the Liquid wave guide capillary cell (2.5 m length path, model 3250, World Precision Instrument). PP samples were measured using a Gynesis spectrophotometer.

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
Methods

Strickland, J. D. H. and Parsons, T. R. (1972). A Practical Hand Book of Seawater Analysis. Fisheries Research Board of Canada Bulletin 157, 2nd Edition, 310 p.
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, DOP were performed using the Liquid wave guide capillary cell (2.5 m length path, model 3250, World Precision Instrument).
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	
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Sampling was performed using Niskin bottles (12 L) mounted on a rosette.
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	Gynesis spectrophotometer
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	PP samples were measured using a Gynesis 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.

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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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