Alkaline phosphatase activities for in situ and incubation samples from RV/Atlantic Explorer cruise AE1812 cruise transect from Bermuda to Rhode Island in May 2018.

Website: https://www.bco-dmo.org/dataset/739973
Data Type: experimental
Version: 1
Version Date: 2018-07-16

Project
» Collaborative Research: Defining the biogeochemical drivers of diatom physiological ecology in the North Atlantic (North Atlantic Diatoms)
» Collaborative Research: Dynamics of dissolved organic phosphorus production, composition and bioavailability along a natural marine phosphate gradient (DOP Dynamics-N Atl)

Contributors	Affiliation	Role
Dyhrman, Sonya T.	Lamont-Doherty Earth Observatory (LDEO)	Principal Investigator
Jenkins, Bethany D.	University of Rhode Island (URI-GSO)	Co-Principal Investigator
Rynearson, Tatiana A.	University of Rhode Island (URI-GSO)	Co-Principal Investigator
Copley, Nancy	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset reports alkaline phosphatase activities (APA) for 3 incubation runs and 33 in situ samples collected on RV/Atlantic Explorer cruise AE1812 in May 2018. The samples were collected between Bermuda and Rhode Island.

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Coverage

Spatial Extent: **N**:40.42 **E**:-56.56 **S**:31.42 **W**:-70.58
Temporal Extent: 2018-05-02 - 2018-05-15

Dataset Description

This dataset reports alkaline phosphatase activities (APA) for 3 incubation runs and 33 in situ samples collected on RV/Atlantic Explorer cruise AE1812 in May 2018. The samples were collected between Bermuda and Rhode Island.

Methods & Sampling

For APA analysis, triplicate biological samples (250 mL) from in situ and incubation samples were filtered onto

47-mm polycarbonate membranes (0.2 µm). Stored at −20°C until analysis.

APA was assayed after Dyhrman and Ruttenberg (2006) using the fluorogenic phosphatase substrate 6,8-difluoro-4-methylumbelliferyl phosphate. Values were normalized to both volume and chl a. Reagents/Abs/Em used:

D-6567 6,8-difluoro-4-methylumbelliferyl phosphate (DiFMUP):
- Storage upon receipt: ≤ 20°C; Desiccate
- Abs/Em = 358/455
- Molecular Formula: C10H7F2O6P
- Molecular Weight: 292.1
- CAS Name/Number: 2H-1-Benzopyran-2-one, 6,8-difluoro-4-methyl-7-(phosphonooxy)-/ 214491-43-7

D-6566 6,8-difluoro-7-Hydroxy-4-Methylcoumarin (DiFMU) - Reference Standard:
- Storage upon receipt: Room temp.; protect from light
- Molecular Formula: C10H6F2O3
- Molecular Weight: 212.15
- CAS Name/Number: 2H-1-Benzopyran-2-one, 6,8-difluoro-7-hydroxy-4-methyl-/ 215868-23-8

Incubation key:
Control = no addition of nutrients or deep water
DSW = deep seawater addition (added 20% deep seawater (700 m))
+P = Added phosphate only (0.5 µM final for incubations 1 and 2, 1 µM final for incubation 3)
+N = Added nitrate only (6 µM final for incubations 1 and 2, 12 µM final for incubation 3)
phi_P = All but P added (N, Si, Fe, B12)
phi_N = All but N added (P, Si, Fe, B12)
-1, -2, -3 = biological replicates

In situ key:
IS = in situ
-1, -2, -3 = biological replicates

Lost = sample was lost

Data Processing Description

BCO-DMO Processing:
-combined 3 incubations and in situ data into one dataset.
-decreased number of decimal places for APA from various to 3.
-changed date format from m/d/yyyy to yyyy-mm-dd
-changed sample name phi symbol to text

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Data Files

File
APA.csv (Comma Separated Values (.csv), 4.71 KB) MD5:a85b927a7e2a67cf8b063e5553870489 Primary data file for dataset ID 739973

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Related Publications

Dyhrman, S. T., & Ruttenberg, K. C. (2006). Presence and regulation of alkaline phosphatase activity in eukaryotic phytoplankton from the coastal ocean: Implications for dissolved organic phosphorus remineralization. Limnology and Oceanography, 51(3), 1381–1390. doi:10.4319/lo.2006.51.3.1381

Parameters

Parameter	Description	Units
incubation	Incubation replicate or in situ sampling	unitless
sample	Sample identifier	unitless
station	Station identification number	unitless
cast	Cast number on cruise	unitless
date_harvest	Day on which samples were filtered and stored; formatted as yyyy-mm-dd	unitless
APA_nmolP_hr_liter	Alkaline phosphatase activity; volume normalized	nanomol Phosphate/hour/liter [nmol P/h/L]
APA_nmolP_hr_ug_chla	Alkaline phosphatase activity; chl a normalized	nanomol Phosphate/hour/microgram chlorophyll-a [nmol P/h/µg Chl a]
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees

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Instruments

Dataset-specific Instrument Name	Biotek Synergy fluorescent plate reader
Generic Instrument Name	plate reader
Dataset-specific Description	Samples were run on a Biotek Synergy fluorescent plate reader using black plates
Generic Instrument Description	Plate readers (also known as microplate readers) are laboratory instruments designed to detect biological, chemical or physical events of samples in microtiter plates. They are widely used in research, drug discovery, bioassay validation, quality control and manufacturing processes in the pharmaceutical and biotechnological industry and academic organizations. Sample reactions can be assayed in 6-1536 well format microtiter plates. The most common microplate format used in academic research laboratories or clinical diagnostic laboratories is 96-well (8 by 12 matrix) with a typical reaction volume between 100 and 200 uL per well. Higher density microplates (384- or 1536-well microplates) are typically used for screening applications, when throughput (number of samples per day processed) and assay cost per sample become critical parameters, with a typical assay volume between 5 and 50 µL per well. Common detection modes for microplate assays are absorbance, fluorescence intensity, luminescence, time-resolved fluorescence, and fluorescence polarization. From: http://en.wikipedia.org/wiki/Plate_reader, 2014-09-0-23.

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Deployments

AE1812

Website	https://www.bco-dmo.org/deployment/739972
Platform	R/V Atlantic Explorer
Start Date	2018-05-01
End Date	2018-05-16

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Project Information

Collaborative Research: Defining the biogeochemical drivers of diatom physiological ecology in the North Atlantic (North Atlantic Diatoms)

Coverage: North Atlantic

NSF abstract:

About half of photosynthesis on earth is generated by marine phytoplankton, single celled organisms that drift with tides and currents. Within the phytoplankton, the diatoms conduct nearly half of this photosynthesis, exerting profound control over global carbon cycling. Despite their importance, there are surprisingly fundamental gaps in understanding how diatoms function in their natural environment, in part because methods to assess in situ physiology are lacking. This project focuses on the application of a powerful new approach, called Quantitative Metabolic Fingerprinting (QMF), to address this knowledge gap and examine species-specific physiology in the field. The project will provide transformative insights into how ocean geochemistry controls the distribution of diatoms, the metabolic responses of individual diatom species, and

how metabolic potential is partitioned between diatom species, thus providing new insights into the structure and function of marine systems. The overarching goal is to examine how diatom species respond to changes in biogeochemistry across marine provinces, from the coast to the open ocean, by following shifts in diatom physiology using QMF. This research is critical to understand future changes in oceanic phytoplankton in response to climate and environmental change. Furthermore, activities on this project will include supporting a graduate student and postdoctoral fellow and delivering the Artistic Oceanographer Program (AOP) to diverse middle school age children and teachers in the NYC metropolitan area and to middle-school girls in the Girl Scouts of RI, reaching an anticipated 60 children and 30 teachers annually. The programs will foster multidisciplinary hands-on learning and will directly impact STEM education at a critical point in the pipeline by targeting diverse middle-school aged groups in both NY and RI.

In laboratory studies with cultured isolates, there are profound differences among diatom species' responses to nutrient limitation. Thus, it is likely that different species contribute differently to nutrient uptake, carbon flux and burial. However, marine ecosystem models often rely on physiological attributes drawn from just one species and apply those attributes globally (e.g. coastal species used to model open ocean dynamics) or choose a single average value to represent all species across the world's oceans. In part, this is due to a relatively poor understanding of diatom physiological ecology and a limited tool set for assessing in situ diatom physiological ecology. This research project will address this specific challenge by explicitly tracking metabolic pathways, measuring their regulation and determining their taxonomic distribution in a suite of environmentally significant diatoms using a state of the art, species-specific approach. A research expedition is set in the North Atlantic, a system that plays a major role in carbon cycling. Starting with a New England coastal shelf site, samples will be collected from the coast where diatoms thrive, to the open ocean and a site of a long term ocean time series station (the Bermuda Atlantic Time Series) where diatom growth is muted by nutrient limitation. This research takes advantage of new ocean observatories initiative (OOI) and time series information. Through the research expedition and downstream laboratory experiments, the molecular pathways of nutrient metabolism and related gene expression in a suite of environmentally significant diatoms will be identified. Data will be combined to predict major limiting factors and potentially important substrates for diatoms across marine provinces. Importantly, this integrated approach takes advantage of new advances in molecular and bioinformatics tools to examine in situ physiological ecology at the species-specific level, a key knowledge gap in the field.

Collaborative Research: Dynamics of dissolved organic phosphorus production, composition and bioavailability along a natural marine phosphate gradient (DOP Dynamics-N Atl)

Coverage: North Atlantic transect from Bermuda to Narragansett, RI

NSF Award Abstract:

Phytoplankton, also known as primary producers, are microscopic floating plants at the base of the marine food web. As photosynthetic organisms, phytoplankton directly take up dissolved inorganic carbon (DIC) to synthesize their tissues using energy from the sun. In addition to carbon (C), essential nutrients such as phosphorus (P) and nitrogen (N) are required by these primary producers. While dissolved inorganic phosphorus (DIP) is the preferred form of P because it is a small enough molecule that phytoplankton can directly absorb it, in the sunlit surface waters of the ocean the concentration of DIP can be drawn down to limiting levels. In this situation, the larger dissolved organic phosphorus (DOP) molecules can become available through enzyme hydrolysis reactions, which convert DOP to DIP. There was mounting evidence that DOP can play a crucial role in supporting primary production in the ocean, yet very little is known about the nature of the DOP pool. There are many analytical impediments to gaining information about the chemical structure and composition of DOP, and without knowledge of its composition there is no basis for evaluating the potential bioavailability of DOP to primary producers. The proposed work will employ a unique combination of methods to gain novel insight into the composition and bioavailability of DOP. Field and laboratory (culture) nutrient addition incubation experiments will target the drivers of DOP variability, information crucial to resolving models of primary production in the ocean. Results of this work will be transformative for understanding DOP composition, DOP variability in space and time, and microbial control on the nature of the marine DOP pool.

This proposal will support a postdoctoral scholar, two undergraduate students and two undergraduate students. Recruitment of undergraduate students will focus on entraining Native Americans and Pacific Islanders, through SACNAS (Society for Advancement of Chicanos/Hispanics and Native Americans in Science) and related venues. Results will be published in peer-reviewed journals and presented at national and

international meetings. We also propose to conduct outreach to middle schools, including bringing The Artistic Oceanographer Program, an interactive inquiry-based program targeting middle school age science and art standards by integrating concepts in ocean science literacy with art, to local middle schools in New York and Hawaii.

The proposed work will provide foundational information on the way DOP molecular characteristics translate into P-bioavailability to marine microorganisms, and in turn how microorganisms growing under different dissolved inorganic nitrogen: dissolved inorganic phosphorus (DIN:DIP) impact the composition and bioavailability of DOP. A newly developed sequential ultrafiltration (SUF) method will be applied to samples collected along a natural P-gradient in the western North Atlantic. The SUF method quantitatively segregates and concentrates DOP into 4 molecular weight size classes, which can be subjected to bioavailability assays using phosphohydrolytic enzymes, and to liquid chromotography-mass spectrometry to provide detailed compositional information. Using these combined methods we will probe in situ DOP, the evolution of in situ DOP during shipboard incubations under different DIN:DIP, and the composition and bioavailability of DOP produced by organisms isolated from key stations along the natural phosphate gradient. Contrast of in situ patterns to those developed in controlled culture experiments using field isolates will be achieved by identifying cellular shifts in organic phosphorus biosynthesis pathways, and tracing how such shifts impact DOP composition. The combined methodological approach will provide unparalleled insight into DOP composition and bioavailability, addressing this major knowledge gap. Results of this work will be transformative for understanding DOP composition, DOP variability in space and time, and microbial control on the nature of the marine DOP pool. Such information is a prerequisite to building ecosystem models that capture the influence of P biogeochemistry on primary production and carbon cycling in aquatic systems.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1558506
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756337
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756964

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