Element quotas of individual Synechococcus cells collected during Bermuda Atlantic Time-series Study (BATS) cruises aboard the R/V Atlantic Explorer between dates 2012-07-11 and 2013-10-13 (Si_in_Syn project)

Website: https://www.bco-dmo.org/dataset/644840
Data Type: Cruise Results
Version: Final
Version Date: 2016-05-06

Project
» Understanding the Role of Picocyanobacteria in the Marine Silicate Cycle (Si_in_Syn)

Contributors	Affiliation	Role
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Coverage

Spatial Extent: **N**:31.6691 **E**:-64.1614 **S**:21.6699 **W**:-65.6664
Temporal Extent: 2012-07-11 - 2013-10-13

Dataset Description

Field work at the Bermuda Atlantic Time Series (BATS) site was done to assess the contribution of Synechococcus and diatoms to total biogenic silica in surface waters. The data include information about the elemental content (Silicon, Phosphorus, and Sulfur) of Synechococcus cells as measured by synchrotron-based x-ray fluorescence (SBXF) microscopy. Derived mole ratios (Si:P, and Si:S) are also provided.

References:

Twining, B. S., Rauschenberg, S., Morton, P. L., & Vogt, S. (2015). Metal contents of phytoplankton and labile particulate material in the North Atlantic Ocean. Progress in Oceanography, 137, 261–283. doi:10.1016/j.pocean.2015.07.001
https://www.researchgate.net/publication/282626294_Metal_contents_of_phytoplankton_and_labile_particulate_material_in_the_North_Atlantic_Ocean

DMO notes:

- Changed formatting of lat/lon to 4 decimal places from 5.
- Elemental content values rounded to two decimal places from 15.

Methods & Sampling

Samples were analyzed as described in Twining et al. (2015).

Bottle samples were collected during BATS cruises from surface level and the deep chlorophyll max (DCM) using a CTD. The SXRF runs were done with a Beamline 2-ID-E during three analytical runs in December 2012, April 2013, and December 2013.

Data Processing Description

Data were processed as described in Twining et al. (2015).

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Data Files

File
si_in_syn.csv(Comma Separated Values (.csv), 10.09 KB) MD5:17a346bf35a2e5ceec900487e12c4bf6 Primary data file for dataset ID 644840

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Related Publications

Twining, B. S., Rauschenberg, S., Morton, P. L., & Vogt, S. (2015). Metal contents of phytoplankton and labile particulate material in the North Atlantic Ocean. Progress in Oceanography, 137, 261–283. doi:10.1016/j.pocean.2015.07.001
Results
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Parameters

Parameter	Description	Units
BATS_bottle_ID	unique identified given to each bottle sample collected on BATS cruises	text
cruise_id	cruise on which sample was collected	text
cast	CTD cast on which whole seawater was collected	text
depth_nom	nominal depth; Surface or DCM (deep cholorophyll max)	text
depth	bottle target trip depth in meters	meters
lat	latitude	decimal degrees
lon	longitude; west is negative	decimal degrees
SXRF_run	SXRF run identifier	text
mda_id	SXRF scan id within the run	text
cell_Si	total silicon content within each Synechococcus cell measured with SXRF	mol/cell
cell_P	total phosphorus content within each Synechococcus cell measured with SXRF	mol/cell
cell_S	total sulfur content within each Synechococcus cell measured with SXRF	mol/cell
cell_Si_to_P	derived mole ratio of silicon to phosphorous for each Synechococcus cell with determinable silicon and phosphorus content	dimensionless
cell_Si_to_S	derived mole ratio of silicon to sulfur for each Synechococcus cell with determinable silicon and sulfur content	dimensionless

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Instruments

Dataset-specific Instrument Name	CTD
Generic Instrument Name	CTD - profiler
Generic Instrument Description	The Conductivity, Temperature, Depth (CTD) unit is an integrated instrument package designed to measure the conductivity, temperature, and pressure (depth) of the water column. The instrument is lowered via cable through the water column. It permits scientists to observe the physical properties in real-time via a conducting cable, which is typically connected to a CTD to a deck unit and computer on a ship. The CTD is often configured with additional optional sensors including fluorometers, transmissometers and/or radiometers. It is often combined with a Rosette of water sampling bottles (e.g. Niskin, GO-FLO) for collecting discrete water samples during the cast. This term applies to profiling CTDs. For fixed CTDs, see https://www.bco-dmo.org/instrument/869934.

Dataset-specific Instrument Name	Synchrotron X-ray Fluorescence Microprobe
Generic Instrument Name	X-ray fluorescence analyzer
Dataset-specific Description	Abbreviation: SXRF For this dataset the model used was: Beamline:2-ID-D The instrument quantifies and maps elements (e.g. Si, Mn, Fe, Ni, S, P) in single cells. Used in the following paper to look at trace elements in aquatic protists: B. Twining, S. Baines, N. Fisher, J. Maser, S. Vogt, C. Jacobsen, A. Tovar-Sanchez, S. Sanudo-Wilhelmy; "Quantifying Trace Elements in Individual Aquatic Protist Cells with a Synchrotron X-ray Fluorescence Microprobe", Analytical Chemistry 2003, 75, 3806-3816. DOI: 10.1021/ac034227z
Generic Instrument Description	Instruments that identify and quantify the elemental constituents of a sample from the spectrum of electromagnetic radiation emitted by the atoms in the sample when excited by X-ray radiation.

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Deployments

AE1218

Website	https://www.bco-dmo.org/deployment/645425
Platform	R/V Atlantic Explorer
Start Date	2012-07-11
End Date	2012-07-16
Description	This is part of the Bermuda Atlantic Time-series Study (BATS).

AE1228

Website	https://www.bco-dmo.org/deployment/645288
Platform	R/V Atlantic Explorer
Start Date	2012-10-18
End Date	2012-10-22
Description	This cruise was part of a Bermuda Atlantic Time-series Study (BATS 286).

AE1322

Website	https://www.bco-dmo.org/deployment/645357
Platform	R/V Atlantic Explorer
Start Date	2013-09-28
End Date	2013-10-13
Description	This cruise is part of the Bermuda Atlantic Time-series Study (BATS).

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Project Information

Understanding the Role of Picocyanobacteria in the Marine Silicate Cycle (Si_in_Syn)

Coverage: Samples collected in western North Atlantic Ocean between Puerto Rico, Bermuda, and Gulf of Maine.

Extracted from the NSF award abstract:

INTELECTUAL MERIT: The investigators will follow-up on their discovery of significant accumulation of silicon by marine picocyanobacteria of the genus Synechococcus to assess the contribution of these organisms to the cycling of biogenic silica in the ocean. Oceanographers have long assumed that diatoms are the dominant marine organisms controlling the cycling of silica in the ocean. Recently, however, single-cell analyses of picocyanobacterial cells from field samples surprisingly revealed the presence of substantial amounts of silicon within Synechococcus. The contribution of Synechococcus to biogenic silica often rivaled that of living diatoms in the two systems examined. Moreover, size fractionation of biogenic silica indicates that up to 25% of biogenic silica can exist in the picoplanktonic size fraction. Given that picocyanobacteria dominate phytoplankton biomass and primary production over much of the world's ocean, these findings raise significant questions about the factors controlling the marine silica cycle globally, as well as the proper interpretation of biogenic silica measurements, Si:N ratios in particulate matter, and ratios of silicate and nitrate depletion. It also suggests that picocyanobacterial populations may be subject to previously unknown constraints on their productivity.

The project will have both laboratory and field components. Because cellular Si varies substantially among the field-collected samples and

laboratory strains so far analyzed, the laboratory component will document variability in Si uptake and cellular Si concentrations, while determining what role physiological and phylogenetic factors play in this variability. The investigators will use strains of Synechococcus for which there are already genome sequences. Laboratory experiments will 1) use 32Si radiotracer uptake experiments to assess the degree of variability in Si content and Si uptake kinetics among strains of Synechococcus acclimated to different levels of silicate, 2) characterize the intracellular distribution and chemistry of silicon within cells using fractionation techniques, density centrifugation, electron microscopy and x-ray absorption spectroscopy, and 3) use bioinformatic analyses of published genomes to determine whether uptake of Si can be predicted based on phylogenetic relationships, to identify candidate genes involved in cyanobacterial Si metabolism, and to develop probes for community structure that can be related to cellular Si content. Field work at the Bermuda Atlantic Time Series (BATS) site will assess the contribution of Synechococcus and diatoms to total biogenic silica in surface waters at times of the year when the former are typically dominant. Field measurements will include size fractionation of biogenic silica biomass and Si uptake, and synchrotron-based x-ray fluorescence microscopy, and the phylogenetic composition of the Synechococcus assemblage.

BROADER IMPACTS: This project has the potential to drive a major paradigm shift in our understanding of the marine silicon cycle. In addition, one PhD student will be trained at Stony Brook. Each PI will provide research experience to a number of undergraduates working on original research projects for credit, as a part of an REU program or as the basis for undergraduate theses. Stony Brook research programs for undergraduates are supported with summer research money from the Undergraduate Research and Creative Activities (URECA) program, and draw on its very diverse student body. The investigators will also engage promising high school level students through several residential programs that the PIs have been a part of in the past. These include the BLOOM program at Bigelow and the Simons Summer Research Fellowship Program at Stony Brook. The PI has continuing relationship with a regional high school (Brentwood) with a high proportion of underrepresented minorities. PI Twining is involved in the Café Scientifique program at Bigelow. Baines will engage in similar outreach through the Center for Science and Mathematics Education (CESAME) sponsored Open Science Nights. Finally, PI Baines will cooperate with CESAMEs teacher education programs, with the aim of incorporating biological oceanography into K-12 curricula. PIs Krause and Brzezinski will incorporate aspects of phytoplankton ecology into UCSB's Oceans to Classroom Program that brings marine research at UCSB to life for over 18,000 K-12 students each year.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1131139
NSF Division of Ocean Sciences (NSF OCE)	OCE-1335012
NSF Division of Ocean Sciences (NSF OCE)	OCE-1131046

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