Water column particulate silica, standing stocks, and productivity rates from R/V Atlantic Explorer cruises AE1218, AE1228, AE1319, AE1322 in Bermuda, and NW Atlantic from 2012-2013 (Si_in_Syn project)

Website: https://www.bco-dmo.org/dataset/672177
Data Type: Cruise Results
Version:
Version Date: 2016-01-05

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**:42.02558 **E**:-63.38301 **S**:21.66985 **W**:-69.20795
Temporal Extent: 2012-07-11 - 2013-10-04

Dataset Description

The data contain water column silica concentrations, silicic acid concentrations, and biomass-normalized biogenic silica production rates. Water samples were collected by R/V Atlantic Explorer cruises AE1218, AE1228, AE1319, and AE1322 between July of 2012 and October of 2013. The data include biogenic and lithogenic silica concentrations for particles greater than 3 um, and between 0.4 to 3 um.

These data were published in:

Krause, J.W., Brzezinski, M.A., Baines, S. B., Collier, J. L., Twining, B. S., Ohnemus, D. C. 2017. Picoplankton contribution to biogenic silica stocks and production rates in the Sargasso Sea. Global Biogeochemical Cycles 31, 762-774. doi: 10.1002/2017GB005619

Methods & Sampling

Bottle samples were collected from CTD casts in the upper 200 m of the water column during R/V Atlantic Explorer cruises, some of which were Bermuda Atlantic Time-series cruises. Cruise AE1218 was BATS283, AE1228 was BATS286, and AE1322 was validation cruise BVAL048.

Silicic acid Si(OH)4 was analyzed using a sensitive manual colorimetric analysis as done previously in this region

[Brzezinski and Nelson, 1995]. Approximately 3 liters of water were filtered for particulate silica concentration through two successive in-line filter holders (47 mm diameter) with pore sizes of 3.0 um followed by 0.4 um, filters were dried at sea, and analyzed on shore using sequential NaOH and HF digestions [Brzezinski and Nelson, 1995], but using Teflon tubes for the digestions [Krause et al., 2009] which provide low and stable blank values.

The rate of biogenic silica production in both size classes was measured using the radioisotope tracer 32Si. 300 mL samples were incubated with high specific activity 32Si(OH)4 (>40 kBq umol / Si). Rate samples were incubated on a surface-tethered array or in acrylic incubators cooled with continually flowing surface water since in situ arrays were not logistically feasible; a series of neutral density screens were used to simulate light levels at depth. After incubation, samples were processed immediately by filtering through 3.0 um and 0.4 um filters sequentially and drying filters on a nylon planchette.

Once dry, the filters and nylon planchette were covered with mylar and secured with a nylon ring. After secular equilibrium was achieved between 32Si and its daughter isotope, 32P (~120 days), sample activity was quantified via gas proportional counting using a GM Multicounter (Riso National Laboratory, Technical University of Denmark); this methodology [Krause et al., 2011] allows for higher precision and a lower detection limit than liquid scintillation counting and is useful for resolving small analytical signals in the picoplankton size fraction.

These data were published in Global Biogeochemical Cycles:
Krause, J.W., Brzezinski, M.A., Baines, S. B., Collier, J. L., Twining, B. S., Ohnemus, D. C. Picoplankton contribution to biogenic silica stocks and production rates in the Sargasso Sea. 2017. Global Biogeochemical Cycles. doi: 10.1002/2017GB005619

References:

Brzezinski, Mark A., and David M. Nelson. "The annual silica cycle in the Sargasso Sea near Bermuda." Deep Sea Research Part I: Oceanographic Research Papers 42.7 (1995): 1215-1237. http://dx.doi.org/10.1016/0967-0637(95)93592-3

Krause, Jeffrey W., David M. Nelson, and Michael W. Lomas. "Biogeochemical responses to late-winter storms in the Sargasso Sea, II: Increased rates of biogenic silica production and export." Deep Sea Research Part I: Oceanographic Research Papers 56.6 (2009): 861-874. http://dx.doi.org/10.1016/j.dsr.2009.01.002

Krause, Jeffrey W., Mark A. Brzezinski, and Janice L. Jones. "Application of low-level beta counting of 32 Si for the measurement of silica production rates in aquatic environments." Marine Chemistry 127.1 (2011): 40-47. http://dx.doi.org/10.1016/j.marchem.2011.07.001

Data Processing Description

“0” value in dataset indicates sample was below analytical detection.

BCO-DMO Data Manager Processing Notes:

* added a conventional header with dataset name, PI name, version date
* modified parameter names to conform with BCO-DMO naming conventions
* -999 values changed to 'nd'
* limited lat lon to 5 decimal places
* replaced blank spaces in station name with underscore
* changed date and time format to yyyy-mm-dd and HH:MM
* added column ISO_DateTime_UTC from provided Zulu date/time

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Data Files

File
Si_field.csv (Comma Separated Values (.csv), 10.85 KB) MD5:c2803a7375679d56e1316f3f850200d4 Primary data file for dataset ID 672177

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Parameters

Parameter	Description	Units
cruise_id	Cruise identifier	unitless
station	Sampling station identifier	unitless
cast	CTD cast identifier	unitless
ISO_DateTime_UTC	ISO timestamp based on the ISO 8601:2004(E) standard in format YYYY-mm-ddTHH:MM:SS[.xx]Z (UTC)	unitless
date_AST	Date of sample (Atlantic Standard Time) in format yyyy-mm-dd	unitless
time_AST	Time of sample (Atlantic Standard Time) in format HH:MM	unitles
cast_max_depth	Maximum depth (nominal) of CTD cast	meters
lat	Latitude of CTD cast; north is positive	decimal degrees
lon	Longitude of CTD cast; west is negative	decimal degrees
bottle_num	CTD water sample bottle number	unitless
target_depth	Targeted depth of water sample	meters
silicic_acid	Dissolved silicic acid Si(OH)4 concentration	micromolar (uM)
bSi_gt_3	Size-fractionated biogenic silica concentration	nanomoles per liter (nmol Si/L)
bSi_4tenths_to_3	Size-fractionated biogenic silica concentration	nanomoles per liter (nmol Si/L)
lSi_above_3	Size-fractionated lithogenic silica concentration	nanomoles per liter (nmol Si/L)
lSi_4tenths_to_3	Size-fractionated lithogenic silica concentration	nanomoles per liter (nmol Si/L)
Rho_above_3	Size-fractionated gross biogenic silica production rate (Greek letter Rho)	nanomoles per liter per day (nmol Si/L/d)

Rho_4tenths_to_3	Size-fractionated gross biogenic silica production rate (Greek letter Rho)	nanomoles per liter per day (nmol Si/L/d)
Vb_above_3	Size-fractionated biomass-normalized biogenic silica production (Vb)	reciprocal days (d-1)
Vb_4tenths_to_3	Size-fractionated biomass-normalized biogenic silica production (Vb)	reciprocal days (d-1)

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Bottle
Generic Instrument Description	A container, typically made of glass or plastic and with a narrow neck, used for storing drinks or other liquids.

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	GM Multicounter
Generic Instrument Name	GM multicounter
Dataset-specific Description	GM Multicounter (Riso National Laboratory, Technical University of Denmark).
Generic Instrument Description	A gas flow multicounter (GM multicounter) is used for counting low-level beta doses. GM multicounters can be used for gas proportional counting of 32Si to 32P. For more information about GM multicounter usage see Krause et. al. 2011.

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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).

AE1319

Website	https://www.bco-dmo.org/deployment/537979
Platform	R/V Atlantic Explorer
Report	http://dmoserv3.whoi.edu/data_docs/Bio_CNP_Ratios/AE1319_Cruise_Report_09182013_reduced2.pdf
Start Date	2013-08-14
End Date	2013-09-11
Description	Cruise for project 'Dimensions of Biodiversity: Biological Controls on the Ocean C:N:P ratios'.

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-1335012

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