# Silica uptake by Synechococcus cells in response to a gradient of silicic acid concentrations from lab experiments at Dauphin Island Sea Lab and University of Santa Barbara between 2012-2015 (Si_in_Syn project)

**Website**: https://www.bco-dmo.org/dataset/674295
**Data Type**: experimental
**Version**:
**Version Date**: 2017-12-04

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

| Contributors | Affiliation | Role |
|---|---|---|
| Krause, Jeffrey W. | Dauphin Island Sea Lab (DISL) | Principal Investigator, Contact |
| Brzezinski, Mark A. | University of California-Santa Barbara (UCSB) | Co-Principal Investigator |
| York, Amber D. | Woods Hole Oceanographic Institution (WHOI BCO-DMO) | BCO-DMO Data Manager |

## Table of Contents



## Coverage

**Spatial Extent**: **N**:41.19 **E**:-65.6 **S**:22.495 **W**:-124.1668

## Dataset Description

Monocultures of four Synechococcus cyanobacterium clones of were used to examine the rate of Si accumulation in response to a gradient of silicic acid concentrations [Si(OH)4] . The data include the silicic acid concentration used during the experiment and the silica uptake rate. The experiments took place at the University of Santa Barbara Marine (UCSB) Science Institute between June and November of 2012 and the Dauphin Island Sea Laboratory (DISL) between March of 2013 and August of 2015.

### Methods & Sampling

Clones (1333, 1334, 2370, 2515) were maintained in aged surface Sargasso Sea water with f/2 media constituents. For each of the four clones, Sargasso Seawater (ambient Si(OH)4 ~1 uM) was amended with 10 - 14 levels of silicic acid. Experiments examined the response of the rate of Si accumulation across a silicic acid concentration gradient from 1 to 50 uM (kinetic_type:low) or from 1 to 500 uM (kinetic_type: high). Only clone 1333 was used for the 1 to 500 uM silicic acid concentration experiment. The high kinetic type experiments took place at the UCSB Marine Science Institute and the low kinetic type experiments took place at DISL.

Each incubation was terminated by filtration and processed for measurement of 32Si activity following Krause et al. (2011). After aging for 120 days, secular equilibrium between 32Si and its daughter 32P was achieved and 32Si activity was determined using gas-flow proportional counting using GM 25-5 multicounters (Risø National Laboratory, Technical University of Denmark).

Full details of culturing and experimental methods are described in Brzezinski et al. (in review). (as of 05 Jan 2017)

#### Data Processing Description

No further processing.

**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
* blank values replaced with no data value 'nd'
* latitude and longitude of Dauphin Island Sea Lab and UCSB Marine Institute added to dataset
* combined data for three separate high kinetic type experiments and added data column "exp_id" which is an identifier to distinguish between data from different experiments.
* combined "low" and "high" kinetic experiment data and created data column "kinetic_type" which has value (high|low)

[ table of contents | back to top ]

## Data Files

| File |
| --- |
| **Si_kinetics.csv** (Comma Separated Values (.csv), 3.23 KB) MD5:06f8093851dd6810213f682c1ca3d80f<br>Primary data file for dataset ID 674295 |

[ table of contents | back to top ]

## Related Publications

Brzezinski, M. A., Krause, J. W., Baines, S. B., Collier, J. L., Ohnemus, D. C., & Twining, B. S. (2017). Patterns and regulation of silicon accumulation in Synechococcus spp. Journal of Phycology, 53(4), 746–761. doi:10.1111/jpy.12545
*Methods*

Krause, J. W., Brzezinski, M. A., & Jones, J. L. (2011). Application of low-level beta counting of 32Si for the measurement of silica production rates in aquatic environments. Marine Chemistry, 127(1-4), 40–47. doi:10.1016/j.marchem.2011.07.001
*Methods*

[ table of contents | back to top ]

## Parameters

| Parameter | Description | Units |
|---|---|---|
| kinetic_type | Kinetic type representing the gradient of silic acid concentrations used (high=1-500uM;low=1-50uM) | unitless |
| exp_id | Experiment identifier | unitless |
| clone_lat | Latitude of the clone collection site | decimal degrees |
| clone_lon | Longitude of the clone collection site | decimal degrees |
| clone_id | Synechococcus clone identifier (NCMA strain and CCMP number) | unitless |
| silicic_acid | Silicic acid concentration [Si(OH)4] | micromolar (uM) |
| uptake_rate | Silica uptake rate | reciprocal hours (h-1) |

[ table of contents | back to top ]

## Instruments

| | |
|---|---|
| **Dataset-specific Instrument Name** | GM 25-5 multicounter |
| **Generic Instrument Name** | GM multicounter |
| **Dataset-specific Description** | GM 25-5 multicounters (Risø 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. |

[ table of contents | back to top ]

## Deployments

**Krause_DISL_2013-2015**

| | |
|---|---|
| **Website** | https://www.bco-dmo.org/deployment/674230 |
| **Platform** | lab Dauphin_Island_Sea_Lab |
| **Start Date** | 2013-03-01 |
| **End Date** | 2015-08-31 |
| **Description** | Laboratory experiments conducted at Dauphin Island sea lab. Clone collection locations included in deployment coordinates. |

**Krause_UCSB_2012**

| | |
|---|---|
| **Website** | https://www.bco-dmo.org/deployment/674232 |
| **Platform** | lab_UCSB |
| **Start Date** | 2012-06-01 |
| **End Date** | 2012-11-30 |

[ table of contents | back to top ]

## 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.

[ table of contents | back to top ]

## Funding


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


[ table of contents | back to top ]