

Synechococcus silica uptake rates from cultures with and without added orthophosphate from laboratory experiments at the Dauphin Island Sea Lab from August of 2013 to September of 2014 (Si_in_Syn project)

Website: <https://www.bco-dmo.org/dataset/674286>

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 |
|-------------------------------------|---|---------------------------------|
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Coverage

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

Dataset Description

This dataset contains silica uptake rates from *Synechococcus* cyanobacteria cultures grown in Sargasso Sea water with and without added orthophosphate. Experiments took place at the Krause Lab at Dauphin Island Sea Laboratory (30.2501,-88.0788) between August of 2013 to September of 2014.

These results are also presented in the following paper:

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

Methods & Sampling

Monocultures of four *Synechococcus* clones (1333, 1334, 2515, 2370) were used to examine variation and controls on Si quotas and rates of Si accumulation. Cultures were procured from the National Center for Marine Algae and Microbiota (NCMA) at the Bigelow Laboratory for Ocean Sciences in Boothbay Harbor, Maine. Many of these clones are also available in other culture collections and have various strain names; here we will refer to each by their NCMA strain number (a.k.a. CCMP number).

Cultures were kept in surface Sargasso seawater (ambient concentrations $\sim 1 \mu\text{M Si(OH)}_4$, $\sim 0.1 \mu\text{M PO}_4$) with added orthophosphate (f/2 level, $36 \mu\text{M}$) as well as the same seawater without added orthophosphate.

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

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 added to dataset
- * Si uptake rate limited to 5 decimal places

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Data Files

| File |
|--|
| P_effect_on_Si_uptake.csv (Comma Separated Values (.csv), 1.14 KB) MD5:1f80d144936fcf84843232a493ad38c4 Primary data file for dataset ID 674286 |

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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](https://doi.org/10.1111/jpy.12545)

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Krause, J. W., Brzezinski, M. A., & Jones, J. L. (2011). Application of low-level beta counting of ^{32}Si 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](https://doi.org/10.1016/j.marchem.2011.07.001)

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Parameters

| Parameter | Description | Units |
|-------------------|---|-------------------------------------|
| clone_id | Synechococcus clone identifier (NCMA strain and CCMP number) | unitless |
| clone_lat | Latitude of the clone collection site | decimal degrees |
| clone_lon | Longitude of the clone collection site | decimal degrees |
| treatment | Shorthand code for additions to culture medium (e.g. N means added nitrate) | unitless |
| uptake_rate | Silica uptake rate | reciprocal hours (h ⁻¹) |
| treatment_descrip | Description of what additions were made to culture medium | unitless |

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Instruments

| | |
|---|---|
| Dataset-specific Instrument Name | GM 25-5 multiscouter |
| Generic Instrument Name | GM multiscouter |
| Dataset-specific Description | Manufactured by Riso Laboratories |
| Generic Instrument Description | A gas flow multiscouter (GM multiscouter) is used for counting low-level beta doses. GM multiscouters can be used for gas proportional counting of ³² Si to ³² P. For more information about GM multiscouter usage see Krause et. al. 2011. |

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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. |

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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:

INTELLECTUAL 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.

Funding

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

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