Element quotas of individual plankton cells collected during IRNBRU (MV1405) and June 2015 Line P cruises

Website: https://www.bco-dmo.org/dataset/841583
Data Type: Cruise Results
Version: 1
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Project
» Collaborative Research: Investigating the Ecological Importance of Iron Storage in Diatoms (Diatom Iron Storage)

Contributors	Affiliation	Role
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Abstract
Element quotas of individual plankton cells collected during the IRNBRU (MV1405) and June 2015 Line P cruises in the North Pacific.

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Coverage

Spatial Extent: **N**:50 **E**:-123.66 **S**:38.66 **W**:-145

Methods & Sampling

R/V Melville 1405 took place in the North Pacific Ocean along the California coast from 32°S to 43°N and extending from -117°E to -127°E. The Line P cruise on CCGS John P. Tully was in the North Pacific Ocean off the coast British Columbia from Vancouver (48°N, 123°W) to Ocean Station Papa (50°N, 145°W).

Samples were collected with trace-metal clean bottles or trace-metal clean pump. A small aliquot of unfiltered seawater was collected following protocols described in Twining et al. (2015). Cellular metals were analyzed with the 2-ID-E microprobe beamline at the Advanced Photon Source, Argonne National Laboratory. Incident beam energy was 10 keV to enable the excitation of Kα fluorescence for elements ranging in atomic number from Si (14) to Zn (30). Element quantification was performed by averaging the spectra from pixels representing the cells of interest. Spectra were also extracted from a background area close to each cell. The spectra were then fit with MAPS, a custom fitting software package (Vogt, 2003). Concentrations were calculated based on conversion factors obtained by running the thin-film standards NBS 1832, NBS 1833, and custom Si, P, and Fe standards made by Micromatter XRF. Cell volume was calculated based on measurements taken from bright field images of the cells and using the equations of Hillebrand et al. (1999). Cellular C was then calculated from the volumes using the equations described in Menden-Deuer and Lessard (2000).

Complete methodology is published in Twining et al. (2020).

Data Processing Description

Data Processing:
SXRF data were excluded if the relative standard deviation of the element peak fit by the model was greater than 20%, indicating poor precision of the model fit.

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Data Files

File
irnbru_sxrf.csv (Comma Separated Values (.csv), 5.10 KB) MD5:a9f18c6ae902b1fa6518d862d70d5da4 Primary data file for dataset ID 841583

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Related Publications

Hillebrand, H., Dürselen, C.-D., Kirschtel, D., Pollingher, U., & Zohary, T. (1999). Biovolume calculation for pelagic and benthic microalgae. Journal of Phycology, 35(2), 403–424. doi:10.1046/j.1529-8817.1999.3520403.x
Methods

Menden-Deuer, S., & Lessard, E. J. (2000). Carbon to volume relationships for dinoflagellates, diatoms, and other protist plankton. Limnology and Oceanography, 45(3), 569–579. doi:10.4319/lo.2000.45.3.0569
Methods

Twining, B. S., Antipova, O., Chappell, P. D., Cohen, N. R., Jacquot, J. E., Mann, E. L., … Tagliabue, A. (2020). Taxonomic and nutrient controls on phytoplankton iron quotas in the ocean. Limnology and Oceanography Letters. doi:10.1002/lol2.10179
Results

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
Methods

Vogt, S. (2003). MAPS : A set of software tools for analysis and visualization of 3D X-ray fluorescence data sets. Journal de Physique IV (Proceedings), 104, 635–638. doi:10.1051/jp4:20030160
Methods

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Parameters

Parameter	Description	Units
Cruise	indicates either IrnBru and Line P cruise	unitless
Station	station number	unitless
Lat_N	station latitude	degrees North
Lon_E	station longitude	degrees East
Depth	depth of sample collection	meters (m)
CellType	classification of diatom type	unitless
Run	analysis year and run	unitless
MDA	unique identifier for each cell	unitless
Volume	biovolume of cell	cubic micrometers (um^3)
cellC	cellular carbon	moles per cell (mol/cell)
cellSi	cellular silicon	moles per cell (mol/cell)
cellMn	cellular manganese	moles per cell (mol/cell)
cellFe	cellular iron	moles per cell (mol/cell)
cellCo	cellular cobalt	moles per cell (mol/cell)
cellNi	cellular nickel	moles per cell (mol/cell)
cellZn	cellular zinc	moles per cell (mol/cell)

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Instruments

Dataset-specific Instrument Name	trace-metal clean pump
Generic Instrument Name	Pump
Generic Instrument Description	A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps

Dataset-specific Instrument Name	trace-metal clean bottles
Generic Instrument Name	Trace Metal Bottle
Generic Instrument Description	Trace metal (TM) clean rosette bottle used for collecting trace metal clean seawater samples.

Dataset-specific Instrument Name	2-ID-E X-ray microprobe beamline
Generic Instrument Name	X-ray fluorescence analyzer
Dataset-specific Description	The 2-ID-E X-ray microprobe beamline at the Advanced Photon Source, Argonne National Laboratory, was used for cellular element analysis.
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

MV1405

Website	https://www.bco-dmo.org/deployment/559966
Platform	R/V Melville
Start Date	2014-07-03
End Date	2014-07-26
Description	Deployment MV1405 on R/V Melville. Cruise took place during July 2014.

2015-009

Website	https://www.bco-dmo.org/deployment/841590
Platform	CCGS John P. Tully
Report	https://datadocs.bco-dmo.org/docs/302/twining/Diatom_Iron_Storage/data_docs/2015-009_cruise_report.pdf
Start Date	2015-06-07
End Date	2015-06-22
Description	This Line P cruise (Cruise 2015-009) was in the North Pacific Ocean off the coast British Columbia from Vancouver (48°N, 123°W) to Ocean Station Papa (50°N, 145°W). More information at https://www.waterproperties.ca/linep/2015-009/index.php

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Project Information

Collaborative Research: Investigating the Ecological Importance of Iron Storage in Diatoms (Diatom Iron Storage)

Coverage: North Pacific, California coast and subarctic gyre

NSF Award Abstract:
Diatoms are responsible for a significant fraction of primary production in the ocean. They are associated with enhanced carbon export and usually dominate the response of phytoplankton to additions of the micronutrient iron in high-nutrient, low-chlorophyll (HNLC) regions. Diatoms, particularly those isolated from the open ocean, appear to have a significant capacity to store iron for later use, and in some groups of diatoms this ability is enabled by the iron storage protein ferritin. Such luxury uptake of iron has long been observed in laboratory cultures and hypothesized to provide diatoms with an ecological benefit in the low-iron waters that cover 40% of the global ocean. However iron storage has been difficult to observe in natural systems due to the methodological challenges of working with mixed plankton assemblages, and a physiological understanding of the impacts of iron on ocean diatoms is lacking. This project combines state-of-the-art high-throughput transcriptomic sequencing and single-cell element analysis with novel laboratory and field incubation experiments to quantify iron storage abilities of cultured and natural diatoms that either contain or lack ferritin and determine the ecological impacts of this process. The overall objective of this project is to examine the ecological importance of iron storage as a selective mechanism controlling the distributions of diatoms along iron gradients in marine ecosystems. The proposed research includes three specific objectives:

A. Determine if there is a consistent physiological difference in the ability of pennate versus centric diatoms to store iron.

B. Examine whether iron storage capacities across diverse diatom taxa consistently provide a mechanistic explanation for continued growth in the absence of iron.

C. Determine whether enhanced iron storage provides diatoms with a competitive within natural phytoplankton assemblages in both coastal and oceanic regions.

Transcriptomic sequencing on a variety of ecologically important pennate and centric diatoms will be used to survey for the presence of ferritin-like genes in order to establish biogeographical and/or phylogenetic patterns of occurrence of diatom ferritin. Laboratory culture experiments will be used to quantify the iron storage abilities of these diatoms, as well as the number of cell divisions that can be supported by the stored iron, providing valuable physiological data to inform the understanding of plankton ecology in iron-limited coastal and HNLC systems. The laboratory experiments will be complemented by measurements of ferritin expression and iron storage in coastal and ocean diatoms sampled across gradients of iron availability on two cruises-of-opportunity to the northeast Pacific Ocean.

The NCBI bioproject page can be found here.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1334632

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