Cellular trace elements collected on cruise RR1604 (GO-SHIP transect IO9N) in the Eastern Indian Ocean from March to April 2016

Website: https://www.bco-dmo.org/dataset/768064
Data Type: Cruise Results
Version: 2
Version Date: 2022-07-12

Project
» Collaborative Research: Regional variation of phytoplankton diversity and biogeochemical functioning in the subtropical Indian Ocean (IO Phytoplankton)

Contributors	Affiliation	Role
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Abstract
This dataset includes measurements of cellular trace elements collected on cruise RR1604 (GO-SHIP transect IO9N) in the Eastern Indian Ocean from March to April 2016.

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Coverage

Spatial Extent: **N**:17 **E**:95 **S**:-28.31 **W**:87.07
Temporal Extent: 2016-03-21 - 2016-04-28

Dataset Description

Cellular trace elements collected on cruise RR1604 (GO-SHIP transect IO9N) in the Eastern Indian Ocean from March to April 2016.

Methods & Sampling

Samples were collected from 5 L Teflon-coated Niskin-X bottles hung on non-metal line, and clean techniques were followed throughout (Bruland et al., 1979). Niskin-X bottles were transferred to a clean lab immediately after retrieval. At most stations a single sample was collected from 20 m. Four-depth profiles extending to 200 m were collected at 6 stations along the transect.

A small aliquot of unfiltered seawater was reserved from the surface-most Niskin-X bottle to collect phytoplankton cells for synchrotron X-ray fluorescence (SXRF) analysis. SXRF samples were 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). Approximately 15 cells were analyzed at each station. Flagellated autotrophs with diameters ranging from 1.65 - 6.6 µm were analyzed using 2D raster scans with 0.5 µm pixel step sizes and detector dwell times from 10-20 sec/pixel.

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).

Data Processing Description

SXRF data quality was assessed and outliers identified in two ways. First, measurements 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. Second, outliers were identified by assessment of cellular log-transformed metal:biomass ratios using an ANCOVA model that included log volume, station, and cell type as effects (JMP, SAS). Ratios were removed if the Jackknife distances of the studentized residuals of this model were greater than 3. Roughly 1% of data were removed from the dataset through this process. Outliers appear as blanks with "3" flags.

Data quality:
Data are flagged with the following:
1 = Good data, passed QC;
3 = Questionable or suspect data, used when a data point was oceanographically inconsistent;
4 = Bad;
6 = Below detection limit.

BCO-DMO Processing:
- modified parameter names (removed units, replaced hyphens and spaces with underscores, added "_flag" to flag columns, replaced blank cells with "nd");
- 2022-07-12 - removed unnecessary columns (named "SXRF_map_filename" and "SXRF_spectrum_filename") and added supplemental file of light images.

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Data Files

File
cellular.csv (Comma Separated Values (.csv), 13.13 KB) MD5:85398a0130696c92e346c2d4186ac00b Primary data file for dataset ID 768064

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Supplemental Files

File
IO9N blanks and QC filename: IO9N_blanks_and_QC_for_BCODMO.xlsx (Microsoft Excel, 12.08 KB) MD5:65e14b249ca8cb18a7207c50faee4ab8 IO9N_blanks_and_QC_for_BCODMO.xlsx
IO9N_BF_BCODMO-20220701T190351Z-001.zip (ZIP Archive (ZIP), 1.28 MB) MD5:925ea3ad61e72be804857be41c415d09 Light images for the cells included in dataset 768064, "Cellular Trace Elements", from Ben Twining. The filenames of these images are provided in the "light_image_filename" column of the dataset.

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Related Publications

Bruland, K. W., Franks, R. P., Knauer, G. A., & Martin, J. H. (1979). Sampling and analytical methods for the determination of copper, cadmium, zinc, and nickel at the nanogram per liter level in sea water. Analytica Chimica Acta, 105, 233–245. doi:10.1016/s0003-2670(01)83754-5 https://doi.org/10.1016/S0003-2670(01)83754-5
Methods

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., Rauschenberg, S., Baer, S. E., Lomas, M. W., Martiny, A. C., & Antipova, O. (2019). A nutrient limitation mosaic in the eastern tropical Indian Ocean. Deep Sea Research Part II: Topical Studies in Oceanography. doi:10.1016/j.dsr2.2019.05.001
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
Results

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
Station	Station number	unitless
MDA	unique identifier for each cell	unitless
Grid_type	substrate to which cells were mounted	unitless
SXRF_run	analysis year and run	unitless
Cell_type	classification of Flag (flagellate), Dino (dinoflagellate), or Pico (picoplankton, < 2um)	unitless
Cell_volume	biovolume of cell	cubic micrometers (um^3)

Cell_C	cellular carbon	mol/cell
Cell_C_flag	quality flag for element indicated: 1 = Good data, passed QC; 3 = Questionable or suspect data, used when a data point was oceanographically inconsistent; 4 = Bad; 6 = Below detection limit.	unitless
Cell_Si	cellular silicon	moles per cell (mol/cell)
Cell_Si_flag	quality flag for element indicated: 1 = Good data, passed QC; 3 = Questionable or suspect data, used when a data point was oceanographically inconsistent; 4 = Bad; 6 = Below detection limit.	unitless
Cell_P	cellular phosphorus	mol/cell
Cell_P_flag	quality flag for element indicated: 1 = Good data, passed QC; 3 = Questionable or suspect data, used when a data point was oceanographically inconsistent; 4 = Bad; 6 = Below detection limit.	unitless
Cell_S	cellular sulfur	mol/cell
Cell_S_flag	quality flag for element indicated: 1 = Good data, passed QC; 3 = Questionable or suspect data, used when a data point was oceanographically inconsistent; 4 = Bad; 6 = Below detection limit.	unitless
Cell_Mn	cellular manganese	mol/cell
Cell_Mn_flag	quality flag for element indicated: 1 = Good data, passed QC; 3 = Questionable or suspect data, used when a data point was oceanographically inconsistent; 4 = Bad; 6 = Below detection limit.	unitless
Cell_Fe	cellular iron	mol/cell
Cell_Fe_flag	quality flag for element indicated: 1 = Good data, passed QC; 3 = Questionable or suspect data, used when a data point was oceanographically inconsistent; 4 = Bad; 6 = Below detection limit.	unitless
Cell_Co	cellular cobalt	mol/cell
Cell_Co_flag	quality flag for element indicated: 1 = Good data, passed QC; 3 = Questionable or suspect data, used when a data point was oceanographically inconsistent; 4 = Bad; 6 = Below detection limit.	unitless
Cell_Ni	cellular nickel	mol/cell
Cell_Ni_flag	quality flag for element indicated: 1 = Good data, passed QC; 3 = Questionable or suspect data, used when a data point was oceanographically inconsistent; 4 = Bad; 6 = Below detection limit.	unitless
Cell_Cu	cellular copper	mol/cell
Cell_Cu_flag	quality flag for element indicated: 1 = Good data, passed QC; 3 = Questionable or suspect data, used when a data point was oceanographically inconsistent; 4 = Bad; 6 = Below detection limit.	unitless
Cell_Zn	cellular zinc	mol/cell
Cell_Zn_flag	quality flag for element indicated: 1 = Good data, passed QC; 3 = Questionable or suspect data, used when a data point was oceanographically inconsistent; 4 = Bad; 6 = Below detection limit.	unitless
light_image_filename	Light image file name; file names here correspond to the image names in the Supplemental File "IO9N_BF_BCODMO-20220701T190351Z-001.zip"	unitless

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Instruments

Dataset-specific Instrument Name	Teflon-coated Niskin-X bottles
Generic Instrument Name	Niskin bottle
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

Dataset-specific Instrument Name	synchrotron X-ray fluorescence (SXRF) analysis
Generic Instrument Name	X-ray fluorescence analyzer
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

RR1604

Website	https://www.bco-dmo.org/deployment/723194
Platform	R/V Roger Revelle
Start Date	2016-03-21
End Date	2016-04-28

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Project Information

Collaborative Research: Regional variation of phytoplankton diversity and biogeochemical functioning in the subtropical Indian Ocean (IO Phytoplankton)

Coverage: GO-SHIP IO9N transect: 20S 95E to 20N 95E

Description from NSF award abstract:
The Indian Ocean accounts for nearly a fifth of global ocean photosynthesis and is likely a key component in global ocean nutrient and carbon cycles. However, the Indian Ocean may be the least studied major marine body on the planet. Our limited understanding suggests extensive variations in physical and chemical environmental conditions, but how this variation influences biodiversity, nutrient stress, and more broadly regional differences in the functioning of phytoplankton is unknown. To help address these gaps, the investigators will conduct a study by joining an already-funded major research cruise to this region. It will cover a northern region with some of the highest temperatures recorded in open ocean waters, an area around 10°S of predicted (but not tested in situ) iron stress, and a southern subtropical gyre with unique nitrogen to

phosphorous(or N:P) ratios. The focus of this project is to quantify and synthesize the interconnectedness of environmental conditions, phytoplankton diversity and genome content, and nutrient biogeochemistry, with the goal of understanding how these may lead to unique biogeochemical regions in Indian Ocean. The research will have broader impacts on many levels. First, it will increase public awareness of the role of phytoplankton on ocean functioning, climate, and people's lives through a new partnership with the Aquarium of the Pacific (AOP), which is the fourth most-attended aquarium in the nation. Secondly, the project will train a postdoctoral scholar as well as a graduate and undergraduate students. Third, the research will dramatically increase our basic knowledge ocean biogeochemistry and in many cases will be the first measurements of their kind made in the Indian Ocean.

This project will address two major questions: How do environmental conditions, phytoplankton diversity, phytoplankton physiology, and biogeochemistry vary across the central Indian Ocean? Are there distinct biogeochemical regimes in the central IO? The researchers hypothesize that environmental conditions, including the relative availability of nitrogen (N) and iron (Fe), lead to three distinct phytoplankton communities and biogeochemical regimes. They will employ a series of advanced analytical tools including high sensitivity measurements of dissolved and particulate nutrients (nitrogen, phosphorus, and iron), genomics, bioassays to test for nutrient stress, and cell-sorting of specific taxa followed by measures of nutrient content and uptake. A focus of this project is to quantify and synthesize the interconnectedness of environmental conditions, phytoplankton diversity and genome content, and nutrient biogeochemistry, and how these lead to unique biogeochemical regions in Indian Ocean. This extensive set of observations can ultimately be linked to ocean models and satellite data to provide a comprehensive view of regional differences in chemistry, biodiversity and phytoplankton biogeochemical functioning in the Indian Ocean.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1559021

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