Cellular trace elements collected on cruise TN280 (GeoMICS project) along Line P in the NE Pacific in May 2012

Website: https://www.bco-dmo.org/dataset/841640
Data Type: Cruise Results
Version: 1
Version Date: 2021-02-24

Project
» The relationship between microbial biogeography and ocean chemistry across a persistent oceanographic "hot spot" in the NE Pacific Ocean (GeoMICS Chem)
» Characterizing biological function across a persistent oceanographic "hotspot" in the NE Pacific Ocean (GeoMICS Bio)

Programs
» GeoMICS (GeoMICS)
» GeoMICS (GeoMICS)

Contributors	Affiliation	Role
Twining, Benjamin	Bigelow Laboratory for Ocean Sciences	Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Cellular trace elements collected on cruise TN280 (GeoMICS project) along Line P in the NE Pacific in May 2012.

Table of Contents

- Coverage
- Dataset Description
  - Methods & Sampling
  - Data Processing Description
- Data Files
- Related Publications
- Parameters
- Instruments
- Deployments
- Project Information
- Program Information
- Funding

Coverage

Spatial Extent: **N**:48.82 **E**:-125.5 **S**:48.58 **W**:-128.67

Methods & Sampling

Samples were collected with trace-metal clean rosette and GO-FLO bottles. 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 K_{α} 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.

[table of contents | back to top]

Data Files

File
geomics_sxrf.csv (Comma Separated Values (.csv), 7.71 KB) MD5:f4cd28687eb140faf59ca4567bde214e Primary data file for dataset ID 841640

[table of contents | back to top]

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

[table of contents | back to top]

Parameters

Parameter	Description	Units
Station	station number	unitless
Lat_N	station latitude	degrees N
Lon_E	station longitude	degrees E
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)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	GO-FLO bottles
Generic Instrument Name	GO-FLO Bottle
Generic Instrument Description	GO-FLO bottle cast used to collect water samples for pigment, nutrient, plankton, etc. The GO-FLO sampling bottle is specially designed to avoid sample contamination at the surface, internal spring contamination, loss of sample on deck (internal seals), and exchange of water from different depths.

Dataset-specific Instrument Name	trace-metal clean rosette 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.

[table of contents | back to top]

Deployments

TN280

Website	https://www.bco-dmo.org/deployment/664928
Platform	R/V Thomas G. Thompson
Start Date	2012-05-16
End Date	2012-05-22

[table of contents | back to top]

Project Information

The relationship between microbial biogeography and ocean chemistry across a persistent oceanographic "hot spot" in the NE Pacific Ocean (GeoMICS Chem)

Coverage: Northeast Pacific Ocean: 48.5N 126W

NSF Award Abstract:
The oceans are undergoing dramatic changes. Currently, two largely independently operating research communities -- geochemists and molecular ecologists -- examine potential biological repercussions of changes in ocean chemistry and physics. Geochemists focus primarily on large-scale resultant chemical features, with limited knowledge of underlying biological drivers. Molecular ecologists focus primarily on biodiversity of microbial ecosystems, with few direct linkages to process rates.

With funding from this Early-Concept Grant for Exploratory Research (EAGER), a marine molecular biologist from the University of Washington, a marine inorganic biochemist from the University of Southern California, and a marine trace metal geochemist from Old Dominion University will conduct a multi-parameter exploratory survey cruise to collect and analyze shared geochemical and molecular data to identify chemical and physical drivers of distinct biogeochemical provinces in the sea. They have targeted a well-defined gradient in biogeochemical properties in the northeast Pacific where high nutrient, low chlorophyll waters limited by iron meet low nutrient, iron-replete waters with the long-term goal of understanding the sensitivity of province boundaries to climate change. The transition zone is a surrogate for a geochemical province boundary and is characterized by high biological activity and strong gradients in chemical parameters.

The team hypothesizes that the physical/chemical front creates a distinctive biome with a disproportionate impact on the biogeochemistry of the region, an attribute that may be a fundamental feature of province boundaries. Accordingly, they will characterize multiple biological and chemical parameters on a detailed surface to seafloor zonal survey across this zone. Biological parameters include metagenomes and metatranscriptomes of the microbial community from surface to seafloor at carefully selected stations and gene-focused surveys at more broadly distributed stations. Chemical parameters at all stations include nutrients and dissolved concentrations of Fe, Cu, Zn, Cd, Mn, Co and Ni, key parameters in the GEOTRACES program. Shipboard work will include short-term (12-24 hr) on-deck incubations to examine relationships between rate processes and changes in community composition.

This project is well suited to EAGER funding. The high risk associated with bringing these two research communities together to synthesize resulting data in meaningful ways is mitigated by the high reward associated with learning how to conduct oceanographic work in entirely new ways, moving beyond correlations to causations between biology and chemistry.

This study is motivated by the results from an NSF-sponsored community workshop that highlighted the transformative potential of bringing these two communities together to address underlying drivers of geochemical provinces. The team will invite cruise participation by a broad representation of the two communities, with a central requisite that all participants are broad thinkers that will readily share data in a timely fashion. Member of the U.S. Ocean Carbon and Biogeochemistry (OCB) Scientific Steering Committee have encouraged submission of a proposal for a post-cruise meeting to share successes and "lessons learned". The results of this EAGER project will allow evaluation of the feasibility of joint molecular/geochemical sectional surveys on the scale of programs such as CLIVAR and GEOTRACES

Characterizing biological function across a persistent oceanographic "hotspot" in the NE Pacific Ocean (GeoMICS Bio)

Coverage: Northeast Pacific Ocean: 48.5N 126W

NSF Award Abstract:
Every cubic centimeter of oceanic water is home to millions of single celled organisms that are the engines of the majority of biological activity in the ocean. These organisms form functional communities that are key to our understanding of how the ocean benefits us through providing ecosystem services and hinders us through disease and harmful algal blooms. The underlying causes that shape the distribution and activity of organisms remain elusive, resulting in impaired predictive ability. This project will bring oceanographic research into the post-genomic era by joining genomics and transciptomics with state of the art tools in proteomics, metabolomics and trace metal analyses to understand the causes for observed biogeography and biological activity. The project is a multi-faceted study of the structure and function of microbial communities along a transect in the Northeast Pacific that crosses an oceanographic "hotspot" that results from the mixing of high nutrient low chlorophyll waters with coastal iron rich waters.

This project is appropriate as an EAGER award due to the high risk associated with combining numerous cutting edge techniques carried out by a highly multidisciplinary team for the first time. The team includes

individuals in the geochemistry community that are accustomed to viewing the end result of biological activity on a large spatial and time integrated scale, and molecular ecologists who interrogate organisms and communities for their evolutionary roots, metabolic capabilities and physiological status. The project is a test bed for an integrated study that includes a complete set of "omics" data along with cell quotas for trace metals. The project will generate a large data set that will be shared with the broader community as well as analyzed by the PIs. Cells in the environment carry out their metabolic processes in the context of a chemical environment. By interrogating cellular functions in the form of the proteome, metabolome and metallome, the investigators are asking the cells to tell us what they sense in the environment and how they respond to what they are sensing. These findings will represent a major step toward redefining how we do oceanography such that a complete understanding of microbial communities can lead us to predictions of how the ocean will respond to ongoing change.

This project follows on an ocean carbon and biogeochemistry workshop that discussed how molecular ecologists might collaborate with geochemists to better understand biogeochemical processes in the world oceans. It is expected that successful completion of this proof of concept cruise will lead to larger interdisciplinary program with the ongoing U.S. Geotraces program. This particular project will demonstrate how using -omics approaches, in conjunction with metagenomic and geochemical sampling, can provide the key to linking structure with function across ocean biomes. As part of this project there will be training for the next generation of oceanographers to work in a multidisciplinary community. Undergraduate students will participate on the cruise and will be entrained in research projects using the data generated. A large data set will be made available to the entire oceanographic community, so that participation will be considerably larger than the small group of investigators participating in the cruise.

[table of contents | back to top]

Program Information

GeoMICS (GeoMICS)

Coverage: Northeast Pacific Ocean: 48.5N 126W

The GeoMICS (Global scale Microbial Interactions across Chemical Surveys) research effort grew out of an Ocean Carbon and Biogeochemistry (OCB) workshop that discussed how molecular ecologists might collaborate with geochemists to better understand biogeochemical processes in the world oceans. The workshop highlighted the potential of bringing these two communities together. The first GeoMICS cruise was carried out in May 2012 on the R/V Thompson along a subset of Line P. Goals included:

- Identify interactions between changes in microbial diversity, community functions, and chemical features across a gradient.
- Coordinate sampling protocols: inorganic geochemistry, organic geochemistry, and molecular biology.

In February 2013, an OCB-sponsored workshop was held to coordinate data analysis among the groups of participants (inorganic geochemists, organic geochemists, molecular ecologists, modelers, and computer scientists).

GeoMICS (GeoMICS)

Coverage: Northeast Pacific Ocean: 48.5N 126W

The GeoMICS (Global scale Microbial Interactions across Chemical Surveys) research effort grew out of an Ocean Carbon and Biogeochemistry (OCB) workshop that discussed how molecular ecologists might collaborate with geochemists to better understand biogeochemical processes in the world oceans. The workshop highlighted the potential of bringing these two communities together. The first GeoMICS cruise was carried out in May 2012 on the R/V Thompson along a subset of Line P. Goals included:

- Identify interactions between changes in microbial diversity, community functions, and chemical features across a gradient.
- Coordinate sampling protocols: inorganic geochemistry, organic geochemistry, and molecular biology.

In February 2013, an OCB-sponsored workshop was held to coordinate data analysis among the groups of participants (inorganic geochemists, organic geochemists, molecular ecologists, modelers, and computer scientists).

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1205232

[table of contents | back to top]