

# Element quotas of individual phytoplankton cells from GEOTRACES-EPZT cruise TN303, 2013.

**Website:** <https://www.bco-dmo.org/dataset/643270>

**Data Type:** Cruise Results

**Version:** 1

**Version Date:** 2016-07-19

## Project

» [U.S. GEOTRACES East Pacific Zonal Transect \(GP16\)](#) (U.S. GEOTRACES EPZT)

» [GEOTRACES Pacific Section: Characterizing biogenic trace elements across productivity and oxygen gradients in the eastern South Pacific](#) (South Pacific biogenic trace elements)

## Program

» [U.S. GEOTRACES](#) (U.S. GEOTRACES)

| Contributors                      | Affiliation   | Role                   |
|-----------------------------------|---|------------------------|
| <a href="#">Twining, Benjamin</a> | Bigelow Laboratory for Ocean Sciences               | Principal Investigator |
| <a href="#">Copley, Nancy</a>     | Woods Hole Oceanographic Institution (WHOI BCO-DMO) | BCO-DMO Data Manager   |

## Abstract

Individual phytoplankton cells were collected on the GEOTRACES East Pacific Zonal Transect cruises were analyzed for elemental content using SXRF (Synchrotron radiation X-Ray Fluorescence). Carbon was calculated from biovolume using the relationships of Menden-Deuer & Lessard (2000). Trace metal concentrations are reported.

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## Coverage

**Spatial Extent:** N:-10.4999 E:-77.3761 S:-16.0004 W:-151.9992

**Temporal Extent:** 2013-10-29 - 2013-12-16

## Dataset Description

Individual phytoplankton cells were collected on the GEOTRACES East Pacific Zonal Transect cruises were analyzed for elemental content using SXRF (Synchrotron radiation X-Ray Fluorescence). Carbon was calculated from biovolume using the relationships of Menden-Deuer & Lessard (2000). Trace metal concentrations are reported.

## Methods & Sampling

Samples were analyzed as described in Twining et al. (2015)

Data were processed as described in Twining et al. (2015)

## Data Processing Description

### BCO-DMO Processing:

- added conventional header with dataset name, PI name, version date
- renamed parameters to BCO-DMO standard
- replaced blank cells with nd

### Additional GEOTRACES Processing:

As was done for the GEOTRACES-NAT data, BCO-DMO added standard US GEOTRACES information, such as the US GEOTRACES event number, to each submitted dataset lacking this information. To accomplish this, BCO-DMO compiled a 'master' dataset composed of the following parameters:

cruise\_id, EXPCODE, SECT\_ID, STNNBR, CASTNO, GEOTRC\_EVENTNO, GEOTRC\_SAMPNO, GEOTRC\_INSTR, SAMPNO, GF\_NO, BTLNBR, BTLNBR\_FLAG, W, DATE\_START\_EVENT, TIME\_START\_EVENT, ISO\_DATETIME, UTC\_START\_EVENT, EVENT\_LAT, EVENT\_LON, DEPTH\_MIN, DEPTH\_MAX, BTL\_DATE, BTL\_TIME, BTL\_ISO\_DATETIME, UTC, BTL\_LAT, BTL\_LON, ODF\_CTDPRS, SMDEPTH, FMDEPTH, BTMDEPTH, CTDPRS, CTDDEPTH.

This added information will facilitate subsequent analysis and inter comparison of the datasets.

Bottle parameters in the master file were taken from the GT-C Bottle and ODF Bottle datasets. Non-bottle parameters, including those from GeoFish tows, Aerosol sampling, and McLane Pumps, were taken from the TN303 Event Log (version 30 Oct 2014). Where applicable, pump information was taken from the PUMP\_Nuts\_Sals dataset.

A standardized BCO-DMO method (called "join") was then used to merge the missing parameters to each US GEOTRACES dataset, most often by matching on sample\_GEOTRC or on some unique combination of other parameters.

If the master parameters were included in the original data file and the values did not differ from the master file, the original data columns were retained and the names of the parameters were changed from the PI-submitted names to the standardized master names. If there were differences between the PI-supplied parameter values and those in the master file, both columns were retained. If the original data submission included all of the master parameters, no additional columns were added, but parameter names were modified to match the naming conventions of the master file.

See the dataset parameters documentation for a description of which parameters were supplied by the PI and which were added via the join method.

2016-07-19: Added chlrophyll.zip file in Description section.

2016-06-21: Added GP16 to dataset name.

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Data Files

| File   |
|--|
| <b>EPZT_cell_elements_joined.csv</b> (Comma Separated Values (.csv), 56.30 KB)<br>MD5:c7e4419440f833a003c79629729e88c4 |
| Primary data file for dataset ID 643270  |

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Supplemental Files

| File   |
|--|
| <b>Cell light images</b><br>filename: epzt_Light_images.zip (ZIP Archive (ZIP), 93.37 MB)<br>MD5:44f40fececd8a415bc6efa29f4552f63<br>Used for cellular element quotas data |
| <b>Chlorophyll images</b><br>filename: epzt_ChI_images.zip (ZIP Archive (ZIP), 49.38 MB)<br>MD5:e09ec015f330ce1f92150e1a217a341d   |
| <b>SXRF maps</b><br>filename: epzt_SXRF_maps.zip (ZIP Archive (ZIP), 16.20 MB)<br>MD5:79d43bc24823804c650b6737457a09e8   |
| <b>SXRF spectra files</b><br>filename: epzt_SXRF_spectra.zip (ZIP Archive (ZIP), 5.04 MB)<br>MD5:0ec32f0b9b2dc9cd19cb6b32de82f973  |

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Related Publications

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/lo2.10179](#)

*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.poccean.2015.07.001](#)

*Results*

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Parameters

| Parameter      | Description  | Units           |
|----------------|--|-----------------|
| project        | GEOTRACES project: Eastern Pacific Zonal Transect  | unitless        |
| cruise_id      | cruise identification  | unitless        |
| STNNBR         | GEOTRACES station number. GEOTRACES master file (see Processing Description). PI-supplied values were identical to those in the intermediate US GEOTRACES master file.   | unitless        |
| BTL_LAT        | station latitude; north is positive. Values were added from the intermediate US GEOTRACES master file (see Processing Description).  | decimal degrees |
| BTL_LON        | station longitude; east is postive. Values were added from the intermediate US GEOTRACES master file (see Processing Description).   | decimal degrees |
| GEOTRC_EVENTNO | Unique identifying number for US GEOTRACES sampling events. Values were added from the intermediate US GEOTRACES master file (see Processing Description).   | unitless        |
| GEOTRC_SAMPNO  | GEOTRACES sample number. Values were added from the intermediate US GEOTRACES master file (see Processing Description). PI-supplied values were identical to those in the intermediate US GEOTRACES master file.                       | unitless        |
| CASTNO         | Cast identifier; numbered consecutively within a station. Values were added from the intermediate US GEOTRACES master file (see Processing Description).   | unitless        |
| CTDDEPTH       | Observation/sample depth in meters; calculated from CTD pressure. Values were added from the intermediate US GEOTRACES master file (see Processing Description).   | meters          |
| SAMPNO         | Unique identifying number for US GEOTRACES samples.  | unitless        |
| BTLNBR         | Alphanumeric characters identifying bottle type (e.g. NIS representing Niskin and GF representing GOFLO) and position on a CTD rosette. Values were added from the intermediate US GEOTRACES master file (see Processing Description). | unitless        |
| BTLNBR_FLAG_W  | quality flag for bottle sample: Flag 0: good value; Flag 1: no value or unknown value; Flag 2: replacement considered good value; Flag 4: not trusted; -999: missing value   | unitless        |

|                              |  |                           |
|------------------------------|--|---------------------------|
| ISO_DATETIME_UTC_START_EVENT | Date and time (UTC) variable recorded at start of event in ISO compliant format. Values were added from the intermediate US GEOTRACES master file (see Processing Description). This standard is based on ISO 8601:2004(E) and takes on the following form: 2009-08-30T14:05:00[.xx]Z (UTC time)           | yyyy-MM-ddTHH:mm:ss.SS'Z' |
| BTL_ISO_DATETIME_UTC         | Date and time (UTC) variable recorded at the bottle sampling time in ISO compliant format. Values were added from the intermediate US GEOTRACES master file (see Processing Description). This standard is based on ISO 8601:2004(E) and takes on the following form: 2009-08-30T14:05:00[.xx]Z (UTC time) | YYYY-mm-ddTHH:MM:SS.ssZ   |
| SXRF_run                     | samples were analyzed by synchrotron x-ray fluorescence (SXRF) during two analytical runs in March 2014 (2014-1) or August 2014 (2014-2).  | unitless                  |
| grid_num                     | GEOTRACES bottle number followed by an internal designation for the grid   | unitless                  |
| mda_id                       | unique identifier given to each SXRF scan during each run  | unitless                  |
| cell_type                    | each cell was classified as either an autotrophic flagellate (Flag); autotrophic dinoflagellate (Dino); diatom; or heterotrophic ciliate.  | unitless                  |
| cell_vol                     | biovolume of each cell estimated from microscope measurements of cell dimensions   | um <sup>3</sup>           |
| cell_C                       | cellular C content calculated from biovolume using the relationships of Menden-Deuer & Lessard (2000)  | mol/cell                  |
| cell_Si                      | total elemental Si content of each cell was measured with SXRF. Details provided in Twining et al. (2015).   | mol/cell                  |
| cell_P                       | total elemental P content of each cell was measured with SXRF. Details provided in Twining et al. (2015).  | mol/cell                  |
| cell_S                       | total elemental S content of each cell was measured with SXRF. Details provided in Twining et al. (2015).  | mol/cell                  |
| cell_Mn                      | total elemental Mn content of each cell was measured with SXRF. Details provided in Twining et al. (2015).   | mol/cell                  |
| cell_Fe                      | total elemental Fe content of each cell was measured with SXRF. Details provided in Twining et al. (2015).   | mol/cell                  |
| cell_Co                      | total elemental Co content of each cell was measured with SXRF. Details provided in Twining et al. (2015).   | mol/cell                  |
| cell_Ni                      | total elemental Ni content of each cell was measured with SXRF. Details provided in Twining et al. (2015).   | mol/cell                  |
| cell_Zn                      | total elemental Zn content of each cell was measured with SXRF. Details provided in Twining et al. (2015).   | mol/cell                  |
| light_image_filename         | light image filename   | unitless                  |
| chl_image_filename           | Chl image filename   | unitless                  |
| SXRF_map_filename            | SXRF map filename  | unitless                  |
| SXRF_spectrum_filename       | SXRF spectrum filename   | unitless                  |

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## Instruments

| Dataset-specific Instrument Name |   |
|----------------------------------|---|
| Generic Instrument Name          | GeoFish Towed near-Surface Sampler                            |
| Generic Instrument Description   | The GeoFish towed sampler is a custom designed near surface ( |

| Dataset-specific Instrument Name |  |
|----------------------------------|--|
| 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 |   |
|----------------------------------|---|
| Generic Instrument Name          | Microscope - Optical  |
| Generic Instrument Description   | Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope". |

|   |  |
|---|--|
| <b>Dataset-specific Instrument Name</b> |  |
| <b>Generic Instrument Name</b>          | X-ray fluorescence analyzer  |
| <b>Dataset-specific Description</b>     | SXRF analysis was performed on the 2-ID-E beamline at the Advanced Photon source (Argonne National Laboratory). The synchrotron consists of a storage ring which produces high energy electromagnetic radiation. X-rays diverted to the 2-ID-E beamline are used for x-ray fluorescence mapping of biological samples. X-rays were tuned to an energy of 10 keV to enable the excitation of K-alpha fluorescence for the elements reported. The beam is focused using Fresnel zoneplates to achieve high spatial resolution; for our application a focused spot size of 0.5um was used. A single element germanium energy dispersive detector is used to record the X-ray fluorescence spectrum. |
| <b>Generic Instrument Description</b>   | 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

|                    |   |
|--------------------|---|
| <b>TN303</b>       |   |
| <b>Website</b>     | <a href="https://www.bco-dmo.org/deployment/499719">https://www.bco-dmo.org/deployment/499719</a>   |
| <b>Platform</b>    | R/V Thomas G. Thompson  |
| <b>Report</b>      | <a href="http://dmoserv3.whoi.edu/data_docs/GEOTRACES/EPZT/GT13_EPZT_ODFReport_All.pdf">http://dmoserv3.whoi.edu/data_docs/GEOTRACES/EPZT/GT13_EPZT_ODFReport_All.pdf</a>   |
| <b>Start Date</b>  | 2013-10-25  |
| <b>End Date</b>    | 2013-12-20  |
| <b>Description</b> | A zonal transect in the eastern tropical South Pacific (ETSP) from Peru to Tahiti as the second cruise of the U.S.GEOTRACES Program. This Pacific section includes a large area characterized by high rates of primary production and particle export in the eastern boundary associated with the Peru Upwelling, a large oxygen minimum zone that is a major global sink for fixed nitrogen, and a large hydrothermal plume arising from the East Pacific Rise. This particular section was selected as a result of open planning workshops in 2007 and 2008, with a final recommendation made by the U.S.GEOTRACES Steering Committee in 2009. It is the first part of a two-stage plan that will include a meridional section of the Pacific from Tahiti to Alaska as a subsequent expedition. Figure 1. The 2013 GEOTRACES EPZT Cruise Track. [click on the image to view a larger version] Additional cruise information is available from the Rolling Deck to Repository (R2R): <a href="http://www.rvdata.us/catalog/TN303">http://www.rvdata.us/catalog/TN303</a> |

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## Project Information

### U.S. GEOTRACES East Pacific Zonal Transect (GP16) (U.S. GEOTRACES EPZT)

**Website:** <http://www.geotraces.org/>

**Coverage:** Eastern Tropical Pacific - Transect from Peru to Tahiti (GP16)

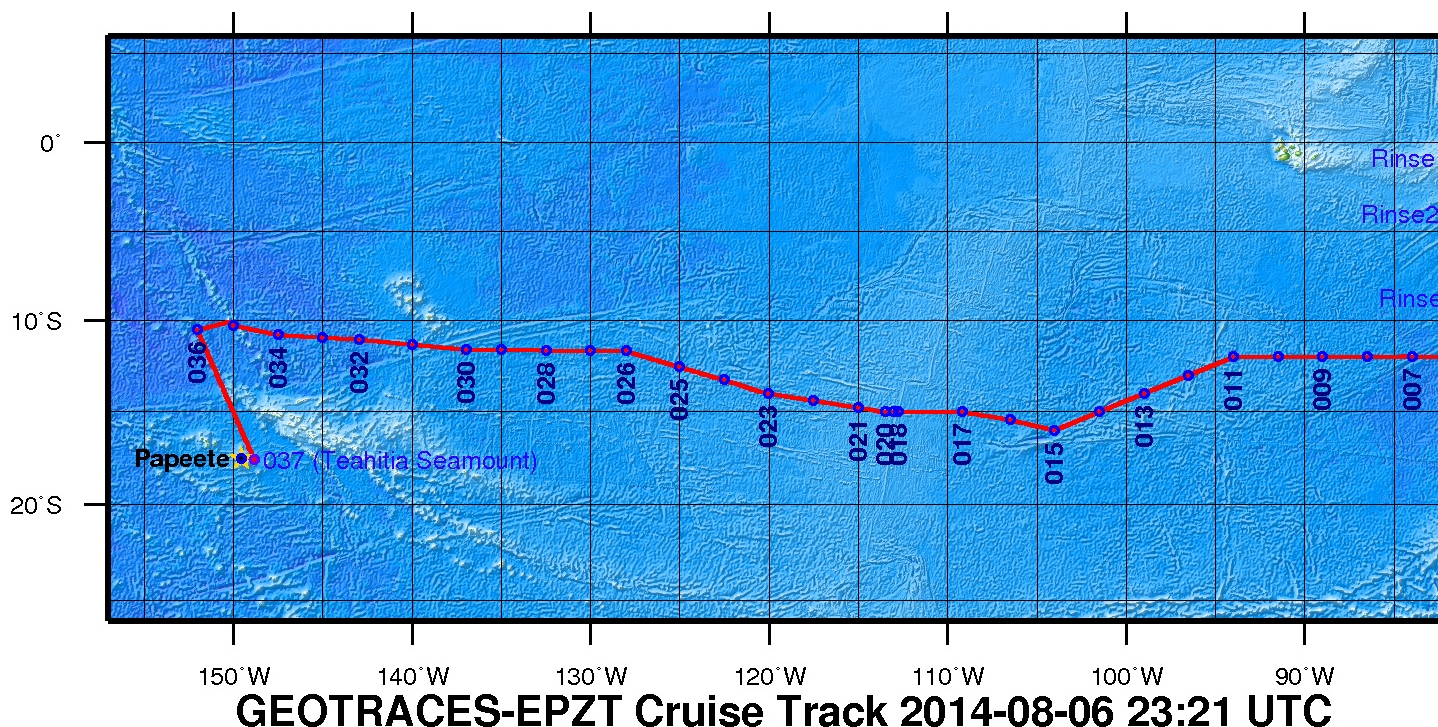
#### From the NSF Award Abstract

The mission of the International GEOTRACES Program (<https://www.geotraces.org/>), of which the U.S. chemical oceanography research community is a founding member, is "to identify processes and quantify fluxes that control the distributions of key trace elements and isotopes in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions" (GEOTRACES Science Plan, 2006). In the United States, ocean chemists are currently in the process of organizing a zonal transect in the eastern tropical South Pacific (ETSP) from Peru to Tahiti as the second cruise of the U.S.GEOTRACES Program. This Pacific section includes a large area characterized by high rates of primary production and particle export in the eastern boundary associated with the Peru Upwelling, a large oxygen minimum zone that is a major global sink for fixed nitrogen, and a large hydrothermal plume arising from the East Pacific Rise. This particular section was selected as a result of open planning workshops in 2007 and 2008, with a final recommendation made by the U.S.GEOTRACES Steering Committee in 2009. It is the first part of a two-stage plan that will include a meridional section of the Pacific from Tahiti to Alaska as a subsequent expedition.

This award provides funding for management of the U.S.GEOTRACES Pacific campaign to a team of scientists from the University of Southern California, Old Dominion University, and the Woods Hole Oceanographic Institution. The three co-leaders will provide mission leadership, essential support services, and management structure for acquiring the trace elements and isotopes samples listed as core parameters in the International GEOTRACES Science Plan, plus hydrographic and nutrient data needed by participating investigators. With this support from NSF, the management team will (1) plan and coordinate the 52-day Pacific research cruise described above; (2) obtain representative samples for a wide variety of trace metals of interest using conventional CTD/rosette and GEOTRACES Sampling Systems; (3) acquire conventional JGOFS/WOCE-quality hydrographic data (CTD, transmissometer, fluorometer, oxygen sensor, etc) along with discrete samples for salinity, dissolved oxygen (to 1 uM detection limits), plant pigments, redox tracers such as ammonium and nitrite, and dissolved nutrients at micro- and nanomolar levels; (4) ensure that proper QA/QC protocols are followed and reported, as well as fulfilling all GEOTRACES Inter-calibration protocols; (5) prepare and deliver all hydrographic-type data to the GEOTRACES Data Center (and US data centers); and (6) coordinate cruise communications between all participating investigators, including preparation of a hydrographic report/publication.

**Broader Impacts:** The project is part of an international collaborative program that has forged strong partnerships in the intercalibration and implementation phases that are unprecedented in chemical oceanography. The science product of these collective missions will enhance our ability to understand how to interpret the chemical composition of the ocean, and interpret how climate change will affect ocean chemistry. Partnerships include contributions to the infrastructure of developing nations with overlapping interests in the study area, in this case Peru. There is a strong educational component to the program, with many Ph.D. students carrying out thesis research within the program.

Figure 1. The 2013 GEOTRACES EPZT Cruise Track. [click on the image to view a larger version]



**GEOTRACES Pacific Section: Characterizing biogenic trace elements across productivity and oxygen gradients in the eastern South Pacific (South Pacific biogenic trace elements)**

**Coverage:** Subtropical Southeastern Pacific Ocean

Incorporation of trace elements (TE) into plankton, and the chemical, geological, biological and biochemical mechanisms which influence this process, are of central importance to our understanding of the biogeochemical functioning of the oceans. Bioactive TEs such as Fe, Zn, Co, Cu and Ni have the potential to control ocean productivity, ecosystem structure, and the utilization of macronutrients in large regions of the global ocean. Numerous laboratory studies have been performed to study the responses of cellular TE quotas in model strains to varying environmental conditions, but accurate measurements of TE stoichiometries in cells and biogenic material collected from natural communities are rare. Measurements of bulk particulate TE stoichiometries typically rely on comparison to laboratory results to assess the biogenic component, precluding study of cellular responses to geochemical gradients.

In this project, investigators at the Bigelow Laboratory for Ocean Sciences and the University of Maine will measure TEs in plankton cells representing major functional groups and in bulk particulate matter along the US GEOTRACES South Pacific Zonal Transect from Peru to Tahiti in 2013. U.S. GEOTRACES is the US component of the international GEOTRACES program which was initiated to advance our knowledge of the concentrations, physical and chemical speciation, and spatial distributions of TEs in the ocean. The Pacific transect will run from a highly productive eastern boundary upwelling system with an intense oxygen minimum zone to the southeast Pacific gyre, one of the world's most oligotrophic regimes. Specifically, the investigators expect to accomplish the following objectives: (1) Measure cellular quotas of P, Si, Mn, Fe, Co, Ni, Cu and Zn in major functional groups of phytoplankton across horizontal productivity gradients in the eastern tropical South Pacific Ocean; (2) Measure cellular quotas of P, Si, Mn, Fe, Co, Ni, Cu and Zn in phytoplankton and bacteria across vertical redox gradients in the OMZ of the eastern tropical South Pacific Ocean; (3) Measure total and labile concentrations of Al, Ti, P, Mn, Fe, Co, Ni, Cu, Zn, Cd, V and Mo in bulk particulate material collected from the upper 500 m with GO-Flo bottles.

**Broader Impacts:** The broader impacts and environmental relevance of this research will be communicated to educators and the general public through a dedicated webinar series to be organized in coordination with COSEE-Ocean Systems. This series will involve 5 webinars delivered sequentially and covering the science results produced by this project, as well as results and synthesis from four other GEOTRACES projects from the South Pacific cruise. These seminars will describe the broader goals and significance of the international GEOTRACES program, promoting this global geochemical program to educators and citizens, as well as synthesizing findings on various aspects of the project (dissolved, particulate, and biogenic trace metals; metal binding ligands; natural radionuclide tracers). Information from GEOTRACES will also be introduced to undergraduate students through Bigelow's REU program and through an undergraduate course being taught to students at nearby Colby College.

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## Program Information

**U.S. GEOTRACES (U.S. GEOTRACES)**

**Website:** <http://www.geotraces.org/>

**Coverage:** Global

**GEOTRACES** is a [SCOR](#) sponsored program; and funding for program infrastructure development is provided by the [U.S. National Science Foundation](#).

GEOTRACES gained momentum following a special symposium, S02: Biogeochemical cycling of trace elements and isotopes in the ocean and applications to constrain contemporary marine processes (GEOSECS II), at a 2003 Goldschmidt meeting convened in Japan. The GEOSECS II acronym referred to the Geochemical Ocean Section Studies. To determine full water column distributions of selected trace elements and isotopes, including their concentration, chemical speciation, and physical form, along a sufficient number of sections in each ocean basin to establish the principal relationships between these distributions and with more traditional hydrographic parameters;

\* To evaluate the sources, sinks, and internal cycling of these species and thereby characterize more completely the physical, chemical and biological processes regulating their distributions, and the sensitivity of these processes to global change; and

\* To understand the processes that control the concentrations of geochemical species used for proxies of the past environment, both in the water column and in the substrates that reflect the water column.

GEOTRACES will be global in scope, consisting of ocean sections complemented by regional process studies. Sections and process studies will combine fieldwork, laboratory experiments and modelling. Beyond realizing the scientific objectives identified above, a natural outcome of this work will be to build a community of marine scientists who understand the processes regulating trace element cycles sufficiently well to exploit this knowledge reliably in future interdisciplinary studies.

Expand "Projects" below for information about and data resulting from individual US GEOTRACES research projects.

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**Funding**

| Funding Source   | Award                       |
|--|-----------------------------|
| <a href="#">NSF Division of Ocean Sciences (NSF OCE)</a> | <a href="#">OCE-1232814</a> |

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