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
Twining, Benjamin	Bigelow Laboratory for Ocean Sciences	Principal Investigator
Copley, Nancy	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, EXPOCODE,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
EPZT_cell_elements_joined.csv (Comma Separated Values (.csv), 56.30 KB) MD5:c7e4419440f833a003c79629729e88c4 Primary data file for dataset ID 643270

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Supplemental Files

File
Cell light images filename: epzt_Light_images.zip (ZIP Archive (ZIP), 93.37 MB) MD5:44f40fececd8a415bc6efa29f4552f63 Used for cellular element quotas data
Chlorophyll images filename: epzt_Chl_images.zip (ZIP Archive (ZIP), 49.38 MB) MD5:e09ec015f330ce1f92150e1a217a341d
SXRF maps filename: epzt_SXRF_maps.zip (ZIP Archive (ZIP), 16.20 MB) MD5:79d43bc24823804c650b6737457a09e8
SXRF spectra files filename: epzt_SXRF_spectra.zip (ZIP Archive (ZIP), 5.04 MB) 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/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
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-dd'T'HH: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^3
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-type Near-surface Towfish Sampler
Generic Instrument Description	This term describes a family of custom-designed, trace-metal-clean, near-surface seawater sampling systems based on the 'GeoFish' design developed by Geoffrey Smith and Ken Bruland at the University of California, Santa Cruz (UCSC). The systems consist of a weighted towed body or torpedo, clean intake tubing, a shipboard pneumatic pump, and a sampling manifold. They are deployed alongside a moving vessel, outside the ship's wake, with the intake typically positioned approximately 1 to 3 meters below the sea surface. Seawater is continuously pumped through the clean tubing to the ship for filtered and unfiltered sampling and, in some applications, direct connection to analytical instruments. This term includes the original GeoFish sampler, Super-GeoFISH variants, and subsequent modified towfish systems used on U.S. GEOTRACES cruises. These systems share the same basic sampling principle but may differ in body construction, depressor or stabilization design, deployment hardware, tubing, pump configuration, flow rate, and sampling manifold. The systems have been used for trace-metal, nutrient, biological, and other chemical measurements in both GEOTRACES and non-GEOTRACES studies, including Bruland et al. (2005).

Dataset-specific Instrument Name	
Generic Instrument Name	GO-FLO Bottle
Generic Instrument Description	A GO-FLO (also written as "Go-Flo") bottle is used to collect discrete water samples at depth, often for analyses of pigments, nutrients, plankton, etc. The GO-FLO sampling bottle, made by General Oceanics, 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".

Dataset-specific Instrument Name	
Generic Instrument Name	X-ray fluorescence analyzer
Dataset-specific Description	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 excition 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.
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

TN303

Website	https://www.bco-dmo.org/deployment/499719
Platform	R/V Thomas G. Thompson
Report	http://dmoserv3.whoi.edu/data_docs/GEOTRACES/EPZT/GT13_EPZT_ODFReport_All.pdf
Start Date	2013-10-25
End Date	2013-12-20
Description	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): http://www.rvdata.us/catalog/TN303

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Project Information

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

Website: http://www.geotraces.org/

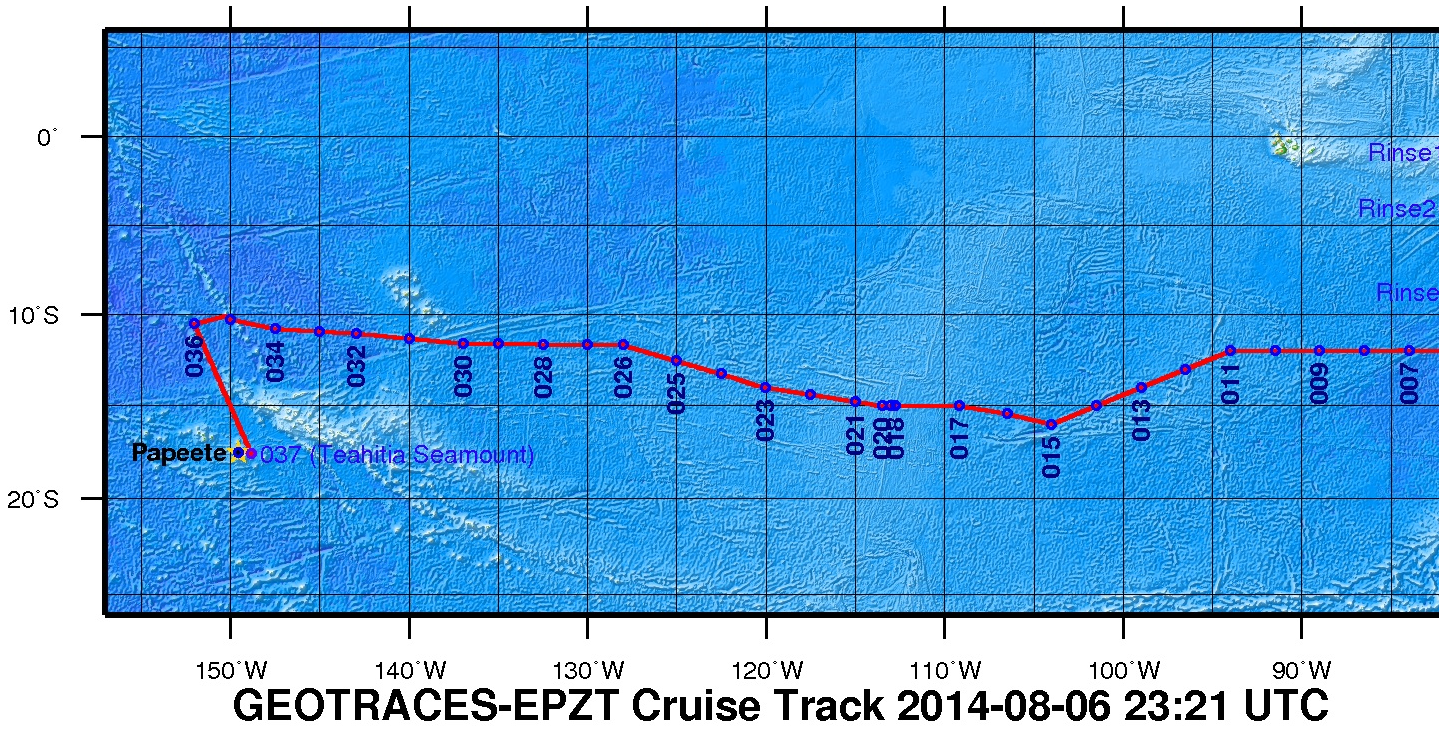
Coverage: Eastern Tropical Pacific - Transect from Peru to Tahiti (GP16)

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 Intercalibration 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-EPZT Cruise Track 2014-08-06 23:21 UTC

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
NSF Division of Ocean Sciences (NSF OCE)	OCE-1232814

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