

Mercury speciation across the US GEOTRACES East Pacific Zonal Transect, from cruise TN303, 2013

Website: <https://www.bco-dmo.org/dataset/643494>

Data Type: Cruise Results

Version:

Version Date: 2016-11-18

Project

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

» [GEOTRACES Pacific Section: Mercury Speciation Along a Zonal Section in the Eastern Tropical South Pacific](#) (EPZT Mercury)

Program

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

Contributors	Affiliation	Role
Lamborg, Carl	University of California-Santa Cruz (UCSC)	Principal Investigator, Contact
Hammerschmidt, Chad	Wright State University	Co-Principal Investigator, Contact
Bowman, Katlin	University of California-Santa Cruz (UCSC)	Contact
Copley, Nancy	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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Coverage

Spatial Extent: N:-10.2294 E:-77.3761 S:-16.0006 W:-152.0385

Temporal Extent: 2013-10-28 - 2013-12-16

Dataset Description

This dataset includes concentrations of filtered total mercury, elemental mercury, monomethylmercury and dimethylmercury from 18 full-depth stations (36 depths each), 13 demi stations (12 depths in upper 1000 m), and 4 stations on the South American margin (6-23 depths).

The FISH and BOTTLE data have been split into separate columns as per GEOTRACES Parameter Naming Conventions. The data is the same as version 2016-04-22. The FISH data are to the far right.

* To access the data with the FISH and BOTTLE data merged, see:

http://data.bco-dmo.org/jg/serv/BCO/GEOTRACES/EPZT/Hg_filtered_joined.html%7Bdir=data.bco-dmo.org/jg/dir/BCO/GEOTRACES/EPZT/info=data.bco-dmo.org/jg/info/BCO/GEOTRACES/EPZT/Hg_filtered%7D

- # version: 2017-07-05 (sample #3095 duplicate records combined)
- # replaces version: 2016-06-13 (bottle and fish samples separated; parameter names revised)
- # replaces original version: 2016-04-22

Methods & Sampling

The dissolved Hg analyses were performed at sea, by both WHOI and Wright State personnel.

- [See Hg Cook Book for full methodology \(PDF\)](#)
- Detailed method descriptions can be found in Lamborg et al., 2012, Hammerschmidt & Bowman, 2012, Bowman et al., 2015
- Sample collection: Cutter & Bruland, 2012
 - TMR - trace metal rosette
 - FISH - trace-metal clean, surface towed pump system
- Sample bottles/cleaning: Hammerschmidt et al., 2012
- All analyses were performed at sea aboard the ship.
- HgT analysis were all performed by analysts from WHOI:
 - Fitzgerald & Gill, 1979, Bloom & Fitzgerald, 1988, Bloom, 1989
 - Tekran Model 2500 CVAFS Mercury Detector
 - Detection limit: 0.03 pM
 - Procedural duplicates: $7 \pm 9\%$ ($n = 29$)
 - Recovery of known additions: $97 \pm 2\%$ ($n = 5$)
- Hg0 analysis were all performed by analysts from WHOI:
 - Fitzgerald & Gill, 1979, Bloom & Fitzgerald, 1988, Bloom, 1989
 - Tekran Model 2500 CVAFS Detector
 - Detection limit: 0.01 pM
 - Procedural duplicates: $20 \pm 15\%$, $n = 27$
 - Recovery of known additions: N/A
- MMHg analysis were all performed by analysts from Wright State:
 - Bowman & Hammerschmidt, 2011, Tseng et al., 2004, Munson et al., 2014
 - Tekran Model 2500 CVAFS Mercury Detector
 - Detection limit: 0.02 pM
 - Procedural duplicates: $35 \pm 22\%$ ($n = 6$)
 - Recovery of known additions: $84 \pm 12\%$ ($n = 3$)
- DMHg analysis were all performed by analysts from Wright State:
 - Bowman & Hammerschmidt, 2011, Tseng et al., 2004, Baya et al., 2013
 - Tekran Model 2500 CVAFS Mercury Detector
 - Detection limit: 0.002 pM
 - Procedural duplicates: $27 \pm 20\%$ ($n = 17$)
 - Recovery of known additions: N/A

"lt_DL" indicates that a sample was below the method detection limit.

Sample volumes were used to calculate picomolar concentrations of different mercury species.

Related References:

Baya, P.A., Hollinsworth, J.L. and Hintelmann, H., 2013. Evaluation and optimization of solid adsorbents for the sampling of gaseous methylated mercury species. *Anal. Chim. Acta*, 786, 61-69.

Bloom, N. 1989. Determination of picogram levels of methylmercury by aqueous phase ethylation, followed by cryogenic gas-chromatography with cold vapor atomic fluorescence detection. *Can. J. Fish. Aquat. Sci.* 46, 1131-1140.

Bloom, N.S., Fitzgerald, W.F. 1988. Determination of volatile mercury species at the picogram level by low-temperature gas chromatography with cold-vapor atomic fluorescence detection. *Anal. Chim Acta* 208, 151-161.

Bowman, K.L., Hammerschmidt, C.R. 2011. Extraction of monomethylmercury from seawater for low-femtogram determination. *Limnol. Oceanogr.: Methods* 9, 121-128.

Bowman, K.L., Hammerschmidt, C.R., Lamborg, C.H. and Swarr, G., 2015. Mercury in the North Atlantic Ocean: The U.S. GEOTRACES zonal and meridional sections. *Deep-Sea Res. Pt. II*, 116, 251-261.

Cutter, G.A., Bruland, K.W. 2012. Rapid and noncontaminating sampling system for trace elements in global ocean surveys. *Limnol. Oceanogr.: Methods* 10, 425-436.

Fitzgerald, W.F., Gill, G.A. 1979. Subnanogram determination of mercury by two-stage gold amalgamation applied to atmospheric analysis. *Anal. Chem.* 51, 1714-1720.

Hammerschmidt, C.R., Bowman, K.L. 2012. Vertical methylmercury distribution in the subtropical North Pacific Ocean. *Mar. Chem.* 132, 77-82.

Hammerschmidt, C.R., Bowman, K.L., Tabatchnick, M.D., Lamborg, C.H. 2011. Storage bottle material and cleaning for determination of total mercury in seawater. *Limnol. Oceanogr.: Methods* 9, 426-431.

Lamborg, C.H., Hammerschmidt, C.R., Gill, G.A., Mason, R.P., Gichuki, S. 2012. An intercomparison of procedures for the determination of total mercury in seawater and recommendations regarding mercury speciation during GEOTRACES cruises. *Limnol. Oceanogr.: Methods*, 10, 90-100.

Munson, K.M., Babi, D. and Lamborg, C.H., 2014. Determination of monomethylmercury from seawater with ascorbic acid-assisted direct ethylation. *Limnol. Oceanogr.-Meth.* 12, 1-9.

Tseng, C.-M., Hammerschmidt, C.R., Fitzgerald, W.F. 2004. Determination of methylmercury in environmental matrixes by on-line flow injection and atomic fluorescence spectrometry. *Anal. Chem.* 76, 7131-7136.

Data Processing Description

BCO-DMO Processing:

- added conventional header with dataset name, PI name, version date
- renamed parameters to BCO-DMO standard
- added cruise_id
- replaced blank cells with nd (no data)
- replaced '<' with 'lt_' ('less than')
- bottle and fish samples separated; parameter names revised

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, CTDDDEPTH.

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.

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Data Files

File
Hg_filtered_joined_fish_btl.csv (Comma Separated Values (.csv), 280.26 KB) MD5:159d75d1b98c5958ce8aafd0723369ed
Primary data file for dataset ID 643494

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Parameters

Parameter	Description	Units
cruise_id	Official cruise identifier	unitless
cruise_name	cruise name used by PI	unitless
STNNBR	station number; provided in original data submission.	integer
date	date; provided in original data submission.	yyyymmdd
time	UTC time; provided in original data submission.	HHMM
lat	latitude; north is positive; provided in original data submission.	decimal degrees
lon	longitude; east is positive; provided in original data submission.	decimal degrees
GEOTRC_SAMPNO	Unique identifying number for US GEOTRACES sample. PI-supplied values were identical to those in the intermediate US GEOTRACES master file. Originally submitted as 'sample'; this parameter name has been changed to conform to BCO-DMO's GEOTRACES naming conventions.	integer
GEOTRC_EVENTNO	Unique identifying number for US GEOTRACES sampling events. Values were added from the intermediate US GEOTRACES master file (see Processing Description).	unitless
inst	instrument; provided in original data submission.	unitless
CASTNO	Cast identifier numbered consecutively within a station. Values were added from the intermediate US GEOTRACES master file (see Processing Description).	unitless
BTL_LAT	Latitude of bottle firing; north is positive. Values were added from the intermediate US GEOTRACES master file (see Processing Description).	decimal degrees
BTL_LON	Longitude of bottle firing; east is positive. Values were added from the intermediate US GEOTRACES master file (see Processing Description).	decimal degrees
ISO_DATETIME.UTC_START_EVENT	Event start date/time (UTC) formatted to ISO8601 standard. T indicates start of time string; Z indicates UTC. Calculated from original date and time fields.	YYYY-mm-ddTHH:MM:SS.ssZ
BTL_ISO_DATETIME.UTC	Bottle date/time (UTC) formatted to ISO8601 standard. T indicates start of time string; Z indicates UTC. Calculated from original date and time fields.	YYYY-mm-ddTHH:MM:SS.ssZ
SAMPNO	Sample number; Values were added from the intermediate US GEOTRACES master file (see Processing Description).	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: 2) ok; 3) questionable; 4) bad analysis; 5) sample lost; 6) mean of replicates	unitless
depth	Depth as reported by PI (CTD coordinates as included in the Pacific cruise Report.)	meters
Hg_TD_CONC_BOTTLE	Total dissolved concentration of mercury from CTD bottle samples (includes gaseous Hg)	picomolar (pM)
Hg_TD_CONC_BOTTLE_FLAG_W	Quality flag: 2) ok; 3) questionable; 4) bad analysis; 5) sample lost; 6) mean of replicates; 9) sample was not collected for Hg analysis	unitless
Hg0_D_CONC_BOTTLE	Concentration of gaseous elemental mercury from CTD bottle samples	picomolar (pM)
Hg0_D_CONC_BOTTLE_FLAG_W	Quality flag: 2) ok; 3) questionable; 4) bad analysis; 5) sample lost; 6) mean of replicates; 9) sample was not collected for Hg analysis	unitless
MMHg_D_CONC_BOTTLE	monomethylmercury concentration from CTD bottle samples	picomolar (pM)
MMHg_D_CONC_BOTTLE_FLAG_W	Quality flag: 2) ok; 3) questionable; 4) bad analysis; 5) sample lost; 6) mean of replicates; 9) sample was not collected for Hg analysis	unitless
DMHg_D_CONC_BOTTLE	dimethylmercury concentration from CTD bottle samples	picomolar (pM)
DMHg_D_CONC_BOTTLE_FLAG_W	Quality flag: 2) ok; 3) questionable; 4) bad analysis; 5) sample lost; 6) mean of replicates; 9) sample was not collected for Hg analysis	unitless
Hg_TD_CONC_FISH	Total dissolved concentration of mercury from GEO-Fish samples (includes gaseous Hg)	picomolar (pM)
Hg_TD_CONC_FISH_FLAG_W	Quality flag: 2) ok; 3) questionable; 4) bad analysis; 5) sample lost; 6) mean of replicates; 9) sample was not collected for Hg analysis	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Cold Vapor Atomic Fluorescence Spectrophotometer
Generic Instrument Description	A Cold Vapor Atomic Fluorescent Spectrophotometer (CVAFS) is an instrument used for quantitative determination of volatile heavy metals, such as mercury. CVAFS make use of the characteristic of mercury that allows vapor measurement at room temperature. Mercury atoms in an inert carrier gas are excited by a collimated UV light source at a particular wavelength. As the atoms return to their non-excited state they re-radiate their absorbed energy at the same wavelength. The fluorescence may be detected using a photomultiplier tube or UV photodiode.

Dataset-specific Instrument Name	
Generic Instrument Name	Pump surface
Dataset-specific Description	trace-metal clean, surface towed pump system
Generic Instrument Description	A source of uncontaminated near-surface seawater pumped onto the deck of the research vessel that can be sampled and analyzed. This pumped seawater supply is from an over-the-side pumping system, and is therefore different from the vessel underway seawater system.

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

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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)

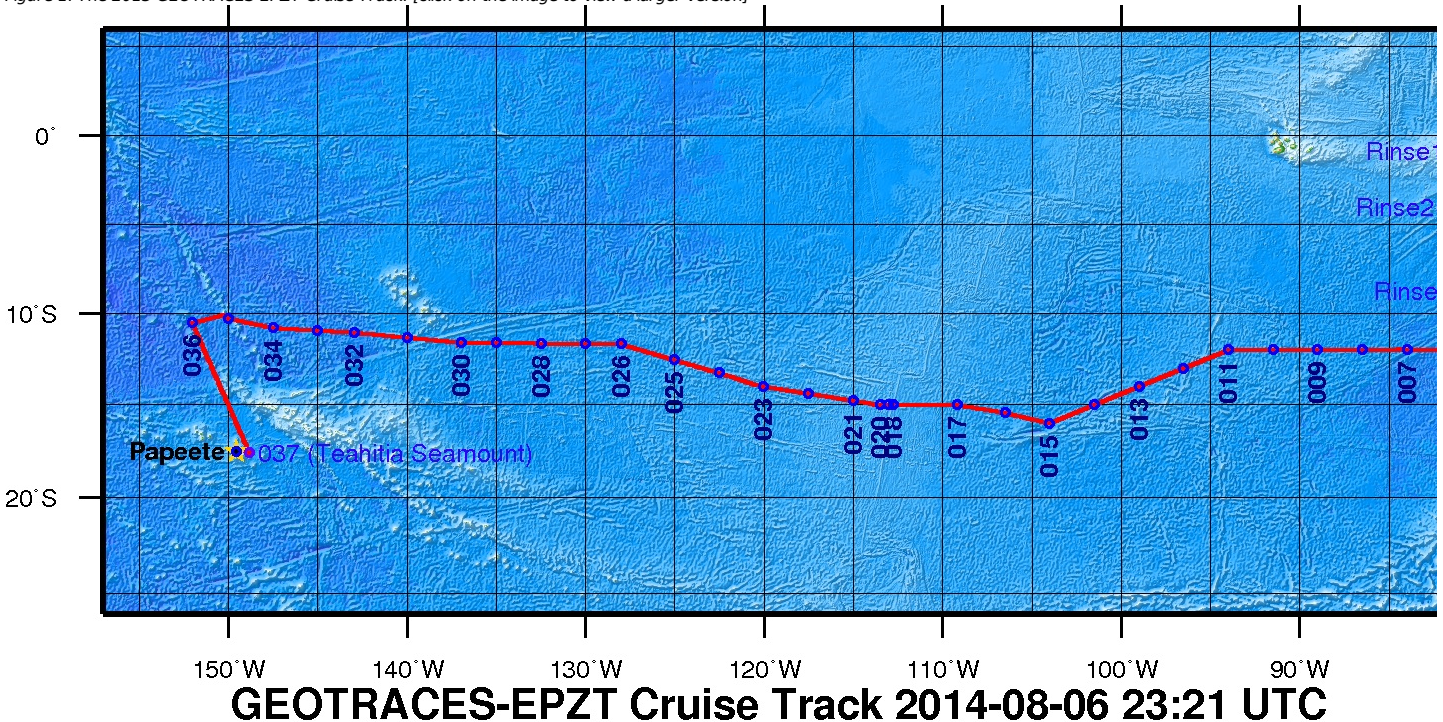
From the NSF Award Abstract

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 Pacific Section: Mercury Speciation Along a Zonal Section in the Eastern Tropical South Pacific (EPZT Mercury)

Coverage: Eastern Tropical South Pacific

Scientists from Wright State University and Woods Hole Oceanographic Institution will participate in the 2013 GEOTRACES cruise to the Eastern Tropical South Pacific (ETSP). Seawater samples collected during this transect from Peru to Tahiti will be analyzed for total mercury (Hg), monomethylmercury (CH₃Hg⁺), dimethylmercury ((CH₃)₂Hg), and elemental Hg (Hg⁰) to construct high-resolution vertical and horizontal sections. In addition to filtered seawater samples, the scientists will also analyze suspended particles for total Hg and CH₃Hg⁺, as well as rain and aerosol samples for Hg species and dissolved and particulate thiols, such as cysteine and glutathione.

The cruise track extends from the upwelling region off Peru, to an expansive oxygen minimum zone (OMZ), followed by the hydrothermal vent fields of the East Pacific Rise, and finally into the highly oligotrophic waters near Tahiti. These different oceanographic features will allow the researchers to determine their influence on the inputs and cycling of Hg in the ocean. Specifically, they plan to assess whether (1) continental margins off Peru are a significant source of Hg, CH₃Hg⁺, and (CH₃)₂Hg; (2) the OMZ sustains the highest levels of methylated Hg in the ocean; (3) hydrothermal systems are important sources of total and methylated Hg; and (4) the large gradient in productivity along this track impact the vertical distribution of this element, its bioavailability, and its speciation.

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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-1232979
NSF Division of Ocean Sciences (NSF OCE)	OCE-1232760

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