Concentration of labile dissolved zinc (dZn) from trace metal clean samples collected on the GEOTRACES GP17 expedition across the South Pacific and Southern Oceans in December 2022 to January 2023 on the R/V Revelle (RR2214)

Website: https://www.bco-dmo.org/dataset/969915
Data Type: Cruise Results
Version: 1
Version Date: 2025-07-30

Project
» US GEOTRACES GP17 Section: South Pacific and Southern Ocean (GP17-OCE) (GP17-OCE)
» US GEOTRACES GP17-OCE and GP17-ANT: Mapping zinc speciation in the Southern Ocean overturning circulation to test the zinc scavenging hypothesis (GP17 Zinc Speciation)

Program
» U.S. GEOTRACES (U.S. GEOTRACES)

Contributors	Affiliation	Role
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Abstract

The concentration of labile dissolved zinc (dZn) was measured in over 600 trace metal clean samples collected by surface tow-fish and trace metal clean rosette. Sampeles were collected and analyzed shipboard on the GEOTRACES GP17 expedition across the South Pacific and Southern Oceans in December 2022 -January 2023 on the R/V Revelle. Labile dZn is operationally defined as the quantity of Zn that binds to an electroactive ligands, pyrrolidine dithiocarbamate (PDC) after a several hour equilibration period.

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Coverage

Location: South Pacific Gyre through Antarctic Zone, 20 - 67S, 75 to 152W, 0 - 5800 m
Spatial Extent: **N**:-19.99986 **E**:-75.09712 **S**:-67.00984 **W**:-152.00029
Temporal Extent: 2022-12-03 - 2023-01-24

Methods & Sampling

Sampling on GP17-OCE:
Clean seawater samples were collected using a GEOTRACES CTD carousel outfitted with 24, 12-liter (L) GoFlo bottles (General Oceanics). Additional samples were collected at 3 meters (m) depth using a surface tow-fish

that was operated while the ship was underway. For more information about sampling regimes, see the BCO-DMO project page for the GP17 expedition (https://www.bco-dmo.org/project/905972) or the GP17-OCE cruise report (linked therein).

Prior to the cruise, 250 milliliters (mL) fluorinated polyethylene (FLPE) bottles were rinsed in citranox detergent for 24 hours and then allowed to soak for 1 week in ca. 10% hydrochloric acid. After each step, bottles were rinsed several times in ultrapure (18.2 mega-ohm cm-1) water and cleaned bottles were stored, double-bagged when not in use. Sample bottles were triple-rinsed and then filled with seawater filtered through a 0.8 / 0.2 micrometer (um) capsule filter (Acropak) in a trace-metal-clean sampling van. Samples were stored at 4 degrees Celsius prior to analysis at sea.

Analytical methods:
A high-throughput electrochemical system was utilized at sea to measure labile dissolved zinc This system consisted of a Metrohm 858 sample processor, Metrohm 800 Dosino burettes, a mercury working electrode and 663 electrode stand, and an Autolab PG101 Potentiostat. The working electrode was set within a PFA analysis cup with a Ag/AgCl reference electrode and glassy carbon counter-electrode. Standard additions of Zn were added using a 2 mL Metohrm 800 Dosino. Sample was loaded into the analysis cup via a 5 mL Metrohm Dosino 800 buret. The cup was rinsed via a set of peristaltic pumps (Metrohm 843) with non-contaminated, filtered seawater collected from the underway tow-fish system. All operations were conducted in NOVA 12.X software.

To prepare for analysis, 12 mL of samples were transferred to conditioned perfluoroalkoxy alkane (PFA) vials and amended with a 7.5 mm borate buffer (pH = 8.1) and 108 uM ammonium pyrrolidine dithiocarbamate (APDC) and allowed to equilibrate for 8-16 hours. At a Zn binding strength of 10^8.4 for a the $Zn(PDC)_2$ complex, the equivalent 'alpha' value for this competitive ligand exchange experiments is 2.95 relative to Zn' (in other words, 75% of unchelated or weakly chelated Zn would be bound to PDC; a strong ligand at 1 nanomolar (nM) concentration with a binding constant of 10^9.5 would compete equally with PDC). After this incubation period, the vials were moved to an autosampler and 10 mL was loaded into the analysis cup and the concentration of the electroactive $Zn(PDC)_2$ complex was determined by cathodic stripping voltammetry using a hanging drop mercury electrode.

The voltammetric protocol consisted of an initial, 150 second purge with high purity N2 gas, followed by 7 measurement cycles consisting of 1) an additional 30 seconds purge, 2) a 120 seconds adsorption period at -0.6 volts (V), 3), a brief, 10 second quiescent period, and 4) a linear sweep between -0.6 V to -1.3 V at a speed of 10 volts per second (V/s). The Zn reduction peak was identified at -1.1 V and quantified by measuring peak area over a linearly-interpolated baseline. For the first 3 cycles, the background Zn was measured. The final 4 cycles consisted of successive and automated standard additions (2 nM for nearly all samples) to determine sample-specific Zn sensitivity. The concentration of labile dissolved Zn was determined by the mean of the peak area of the background Zn, divided by the sensitivity.

Analytical Performance:
For all samples measured, median R2 for linear regression of standard additions was 0.996 and the median relative standard deviation of the triplicate baseline scans was 4.5%. An analysis blank of 0.2 nM was subtracted, reflecting the input of Zn from reagents and electrochemical noise.

Performance of the electrochemical system was assessed by in-house standards. For high concentrations, a batch of seawater collected at 1000 m was analyzed throughout the cruise (5.32 +/- 0.51 nM; n = 52). For low concentrations, a sample from the upper water column of Station ALOHA was measured to be 1.12 +/- 0.36 (n = 61).

To assess accuracy, we measured the Zn concentration with the SAFe D2 standard after neutralizing the pH with ammonium hydroxide and a larger addition of borate buffer. We found a mean value of 6.98 +/- 0.62 nM, which overlaps with the reported "consensus" value for this sample (7.43 +/- 0.25 nM).

Data Processing Description

Quality control and data flags:
Data quality flags followed the SeaDataNet Labeling Scheme:

1. Good value, mean of multiple measurements

2. Probably good value, one replicate rejected or single measurement

3. Probably bad value

4. Bad value

9. Missing value

Of the 647 samples measured for the GP17-OCE transect, 612 were analyzed at least twice. For the majority of repeat analyses (70%), good agreement was observed between replicates and samples were averaged. For these analyses, the average standard deviation was 0.32 nM and the average concentration was 3.67 nM, i.e. a mean RSD of +/- 9.1 %. These samples were assigned a data quality flag of 1. For 28% of replicate samples, one replicate was rejected due to differences in instrument performance or lack of oceanographic consistency with neighboring samples that was not observed in the other replicate. These samples were assigned a data quality flag of 2. Samples with only a single measured value were also given a data quality flag of 2.

For samples with quality flags of 2, uncertainty at a given concentration was estimated by linear regression of the sample standard deviation against the mean value. This regression was conducted for all measurements assigned a quality flag of 1. The best-fit regression yielded an intercept of 0.059 nM (i.e. fixed uncertainty) and a slope of 0.064 nM/nM (proportional uncertainty) (R-squared = 0.244).

BCO-DMO Processing Description

- Imported original file "Hawco_Labile_Zn_RR2214_4_25.xlsx" into the BCO-DMO system.
- Populated the "Gear ID" field.
- Renamed fields to comply with BCO-DMO naming conventions.
- For the bottle samples, joined the data to the GP17-OCE GTC Bottle file ("927640_v1_gp17-oce_gtc_bottle.csv") based on GETORACES sample number; populated the following columns using information from the bottle file: Event_ID, Start_ISO_DateTime_UTC.
- For the GeoFish samples, joined the data to the GP17-OCE Event log ("927550_v2_gp17-oce_event_log.csv") based on GEOTRACES sample number; populated the following columns using information from the event log: Event_ID, Start_ISO_DateTime_UTC.
- Added event numbers and date-times for station 14, cast 2 samples using information on the sample log sheet.
- Saved the final file as "969915_v1_gp17_labile_zn.csv".

Problem Description

Data quality flags followed the SeaDataNet Labeling Scheme:
1. Good value, mean of multiple measurements
2. Probably good value, one replicate rejected or single measurement
3. Probably bad value
4. Bad value
9. Missing value

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Related Datasets

IsRelatedTo

Twining, B., Cutter, G. A., Fitzsimmons, J. N. (2025) **Bottle data from CTD profiles from the GTC rosette deployed on the US GEOTRACES GP17-OCE cruise on R/V Roger Revelle (RR2214) from December 2022 to January 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-06-04 doi:10.26008/1912/bco-dmo.927640.1 [view at BCO-DMO]
Relationship Description: Event numbers, dates, and times were retrieved from the bottle file.

Twining, B., Cutter, G. A., Fitzsimmons, J. N. (2025) **Scientific sampling event log from the US GEOTRACES GP17-OCE cruise on R/V Roger Revelle (RR2214) from December 2022 to January 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 2) Version Date

2025-06-06 doi:10.26008/1912/bco-dmo.927550.2 [view at BCO-DMO]
Relationship Description: Event numbers, dates, and times were retrieved from the event log.

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Parameters

Parameter	Description	Units
Station_ID	GP17-OCE station number	unitless
Event_ID	Cruise event number	unitless
Gear_ID_if_applicable	Sampling instrument	unitless
Start_ISO_DateTime_UTC	Date and time (UTC) of event	unitless
Start_Latitude	Station location latitude	degrees North
Start_Longitude	Station location longitude	degrees East
Sample_ID	Unique GEOTRACES sample identifier that can be co-located with other parameters on GP17	unitless
Sample_Depth	Nominal sampling depth	meters (m)
Zn_D_CONC_BOTTLE_zxqan3	The quantity of zinc measured by electrochemistry at pH 8.1 in units of nanomoles per kilogram; sampled from the trace metal rosette.	nanomoles per kilogram (nmol/kg)
SD1_Zn_D_CONC_BOTTLE_zxqan3	Uncertainty of the labile Dissolved Zinc concentration, expressed as the standard deviation of measured values (Quality Flag 1) or an general estimate of the uncertainty based on the correlation with sample standard deviation and Labile Dissolved Zinc concentration (Quality Flag 2)	nanomoles per kilogram (nmol/kg)
Flag_Zn_D_CONC_BOTTLE_zxqan3	Quality Flag Scheme following recommended SeaDataNet numbering schemes. 1 = Good Value, mean of multiple measurements, 2 = probably good value [singular analysis, or 1 replicate excluded], 3 = probably bad value, 4 = bad value, 9 = missing value.	unitless
Zn_D_CONC_FISH_sevpwp	The quantity of zinc measured by electrochemistry at pH 8.1 in units of nanomoles per kilogram; sampled from the surface towed fish.	nanomoles per kilogram (nmol/kg)

SD1_Zn_D_CONC_FISH_sevpwp	Uncertainty of the Labile Dissolved Zinc concentration, expressed as the standard deviation of measured values (Quality Flag 1) or an general estimate of the uncertainty based on the correlation with sample standard deviation and Labile Dissolved Zinc concentration (Quality Flag 2)	nanomoles per kilogram (nmol/kg)
Flag_Zn_D_CONC_FISH_sevpwp	Quality Flag Scheme following recommended SeaDataNet numbering schemes. 1 = Good Value, mean of multiple measurements, 2 = probably good value [singular analysis, or 1 replicate excluded], 3 = probably bad value, 4 = bad value, 9 = missing value.	unitless

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Instruments

Dataset-specific Instrument Name	Super-GeoFISH towed surface vehicle
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	GO-FLO Bottle
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	Metrohm 663 VA stand
Generic Instrument Name	Metrohm 663 VA Stand mercury electrode
Generic Instrument Description	The Metrohm 663 VA stand forms the wet chemical part of a polarographic and voltammetric analytical system. It features a mercury electrode, an Ag/AgCl reference electrode and a glassy carbon counter electrode. The size of the mercury drop and the stirrer speed are set manually on the VA Stand. The VA Stand can be operated in Dropping Mercury Electrode (DME), Hanging Mercury Drop Electrode (HMDE) and Static Mercury Drop Electrode (SMDE) modes. The VA Stand can be controlled by a potentiostat in conjunction with the Metrohm IME663 interface.

Dataset-specific Instrument Name	Metrohm 800 Dosino
Generic Instrument Name	Metrohm 800 Dosino dosing drive
Generic Instrument Description	A dosing drive which can be used with a number of different Metrohm dosing devices or Metrohm titrators for simple dosing, titrations, complex automation and liquid handling tasks such as sample transfers or pipetting. This instrument uses a push rod to deliver liquid, via cylinders of variable sizes, to the attached dosing unit. The 800 Dosino can be used with cylinder sizes: 2 mL, 5 mL, 10 mL, 20 mL, or 50 mL.

Dataset-specific Instrument Name	Metrohm 843 Peristaltic Pumps
Generic Instrument Name	Metrohm 843 peristaltic pump
Generic Instrument Description	The Metrohm 843 peristaltic pump operates at a flow rate of > 450 mL/min (at a pressure of 2 m) and can be used to provide a constant flow of fluid for e.g. rinsing sample containers. The pump station has two in-built membrane pumps which can be controlled directly via the interface using remote signals or manually by pressing a button. The pump can be supplied with additional accessories to suit different needs (e.g. for VA applications) and additional control instruments can be connected to the pump as well as other system instruments.

Dataset-specific Instrument Name	Metrohm 858 sample processor
Generic Instrument Name	Metrohm 858 sample processor
Generic Instrument Description	The Metrohm 858 Professional Sample Processor is an instrument with many applications that was conceived for preparing samples for ion chromatography. Inline filtration, dialysis, preparing dilutions, sample preconcentration, inline calibration, partial loopfill, etc. are techniques that can be used with the 858 Professional Sample Processor. The 858 Professional Sample Processor is designed for usage as an automation system in analytical laboratories. The 858 Professional Sample Processor has the following characteristics: turntable with interchangeable sample rack; tower with a lift equipped with a precision drive with robotic arm to which a needle holder or other working heads can be attached; several types of connectors for use with other devices; and depending on the model, two-channel peristaltic pump and/or returnable injection valve.

Dataset-specific Instrument Name	Autolab PG101 Potentiostat
Generic Instrument Name	Metrohm Autolab PG101 potentiostat
Generic Instrument Description	The Metrohm Autolab PG101 potentiostat/galvanostat is a computer-controlled voltammetry analyser that, when used as part of a larger electrochemical system (e.g. with a Metrohm 663 VA Stand mercury electrode), obtains information about an analyte by applying a potential and measuring the current produced in the analyte. The potentiostat operates at an applied potential range of -10 to 10 V (accuracy: +/- 0.2%; resolution: 150 uV), a maximum bandwidth of 1 MHz, and an input impedance of 100 GOhm. The instrument can supply and measure currents of up to 100 mA with a +/- 0.2% accuracy and a resolution of up to 0.015%. All operations for the Metrohm Autolab PG101 are conducted with NOVA software.

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Deployments

RR2214

Website	https://www.bco-dmo.org/deployment/905754
Platform	R/V Roger Revelle
Report	https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/rogerrevelle_rr2214.pdf
Start Date	2022-12-01
End Date	2023-01-25
Description	The U.S. GEOTRACES GP17-OCE expedition departed Papeete, Tahiti (French Polynesia) on December 1st, 2022 and arrived in Punta Arenas, Chile on January 25th, 2023. The cruise took place in the South Pacific and Southern Oceans aboard the R/V Roger Revelle with a team of 34 scientists led by Ben Twining (Chief Scientist), Jessica Fitzsimmons, and Greg Cutter (Co-Chief Scientists). GP17 was planned as a two-leg expedition, with its first leg (GP17-OCE) as a southward extension of the 2018 GP15 Alaska-Tahiti expedition and a second leg (GP17-ANT; December 2023-January 2024) into coastal and shelf waters of Antarctica's Amundsen Sea. The GP17-OCE section encompassed three major transects: (1) a southbound pseudo-meridional section (~152-135 degrees West) from 20 degrees South to 67 degrees South; (2) an eastbound zonal transect from 135 degrees West to 100 degrees West; (3) and a northbound section returning to Chile (100-75 degrees West). Additional cruise information is available from the following sources: R2R: https://www.rvdata.us/search/cruise/RR2214 CCHDO: https://cchdo.ucsd.edu/cruise/33RR20221201 More information can also be found at: https://usgeotraces.ldeo.columbia.edu/content/gp17-oce

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Project Information

US GEOTRACES GP17 Section: South Pacific and Southern Ocean (GP17-OCE) (GP17-OCE)

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

Coverage: Papeete, Tahiti to Punta Arenas, Chile

The U.S. GEOTRACES GP17-OCE expedition departed Papeete, Tahiti (French Polynesia) on December 1st, 2022 and arrived in Punta Arenas, Chile on January 25th, 2023. The cruise took place in the South Pacific and Southern Oceans aboard the R/V Roger Revelle (cruise ID RR2214) with a team of 34 scientists lead by Ben Twining (Chief Scientist), Jessica Fitzsimmons and Greg Cutter (Co-Chief Scientists). GP17 was planned as a two-leg expedition, with its first leg (GP17-OCE) as a southward extension of the 2018 GP15 Alaska-Tahiti expedition and a second leg (GP17-ANT; December 2023-January 2024) into coastal and shelf waters of Antarctica's Amundsen Sea.

The South Pacific and Southern Oceans sampled by GP17-OCE play critical roles in global water mass circulation and associated global transfer of heat, carbon, and nutrients. Specific oceanographic regions of interest for GP17-OCE included: the most oligotrophic gyre in the global ocean, the Antarctic Circumpolar Current (ACC) frontal region, the previously unexplored Pacific- Antarctic Ridge, the Pacific Deep Water (PDW) flow along the continental slope of South America, and the continental margin inputs potentially emanating from South America.

Further information is available on the US GEOTRACES website and in the cruise report (PDF).

NSF Project Title: Collaborative Research: Management and Implementation of US GEOTRACES GP17 Section: South Pacific and Southern Ocean (GP17-OCE)

NSF Award Abstract:
This award will support the management and implementation of a research expedition from Tahiti to Chile that will enable sampling for a broad suite of trace elements and isotopes (TEI) across oceanographic regions of importance to global nutrient and carbon cycling as part of the U.S. GEOTRACES program. GEOTRACES is a global effort in the field of Chemical Oceanography, the goal of which is to understand the distributions of trace elements and their isotopes in the ocean. Determining the distributions of these elements and isotopes will increase understanding of processes that shape their distributions, such as ocean currents and material fluxes, and also the processes that depend on these elements, such as the growth of phytoplankton and the support of ocean ecosystems. The proposed cruise will cross the South Pacific Gyre, the Antarctic Circumpolar Current, iron-limited Antarctic waters, and the Chilean margin. In combination with a proposed companion GEOTRACES expedition on a research icebreaker (GP17-ANT) that will be joined by two overlapping stations, the team of investigators will create an ocean section from the ocean's most nutrient-poor waters to its highly-productive Antarctic polar region - a region that plays an outsized role in modulating the global carbon cycle. The expedition will support and provide management infrastructure for additional participating science projects focused on measuring specific external fluxes and internal cycling of TEIs along this section.

The South Pacific Gyre and Pacific sector of the Southern Ocean play critical roles in global water mass circulation and associated global transfer of heat, carbon, and nutrients, but they are chronically understudied for TEIs due to their remote locale. These are regions of strong, dynamic fronts where sub-surface water masses upwell and subduct, and biological and chemical processes in these zones determine nutrient stoichiometries and tracer concentrations in waters exported to lower latitudes. The Pacific sector represents an end member of extremely low external TEI surface fluxes and thus an important region to constrain inputs from the rapidly-changing Antarctic continent. Compared to other ocean basins, TEI cycling in these regions is thought to be dominated by internal cycling processes such as biological uptake, regeneration, and scavenging, and these are poorly represented in global ocean models. The cruise will enable funded investigators to address research questions such as: 1) what are relative rates of external TEI fluxes to this region, including dust, sediment, hydrothermal, and cryospheric fluxes? 2) What are the (micro) nutrient regimes that support productivity, and what impacts do biomass accumulation, export, and regeneration have on TEI cycling and stoichiometries of exported material? 3) What are TEI and nutrient stoichiometries of subducting water masses, and how do scavenging and regeneration impact these during transport northward? This management project has several objectives: 1) plan and coordinate a 55-day research cruise in 2021-2022; 2) use both conventional and trace-metal 'clean' sampling systems to obtain TEI samples, as well as facilitate sampling for atmospheric aerosols and large volume particles and radionuclides; 3) acquire hydrographic data and samples for salinity, dissolved oxygen, algal pigments, and macro-nutrients; and deliver these data to relevant repositories; 4) ensure that proper QA/QC protocols, as well as GEOTRACES intercalibration protocols, are followed and reported; 5) prepare the final cruise report to be posted with data; 6) coordinate between all funded cruise investigators, as well as with leaders of proposed GP17-ANT cruise; and 7) conduct broader impact efforts that will engage the public in oceanographic research using immersive technology. The motivations for and at-sea challenges of this work will be communicated to the general public through creation of immersive 360/Virtual Reality experiences, via a collaboration with the Texas A&M University Visualization LIVE Lab. Through Virtual Reality, users will experience firsthand what life and TEI data collection at sea entail. Virtual reality/digital games and 360° experiences will be distributed through GEOTRACES outreach websites, through PI engagement with local schools, libraries, STEM summer camps, and adult service organizations, and through a collaboration with the National Academy of Sciences.

US GEOTRACES GP17-OCE and GP17-ANT: Mapping zinc speciation in the Southern Ocean overturning circulation to test the zinc scavenging hypothesis (GP17 Zinc Speciation)

Coverage: South Pacific Ocean, Southern Ocean

NSF Award Abstract:
The Southern Ocean plays a significant role in the global carbon cycle because deep ocean waters rich in CO2 are brought into the surface layer and can exchange with the atmosphere. The growth of phytoplankton counteracts this carbon source by fixing CO2 into biomass, which can sink back to the deep sea. While the Southern Ocean is rich in macronutrients that support phytoplankton growth, key micronutrients such as iron, manganese and zinc are at very low abundance. Of these metals, only iron has been found to limit phytoplankton productivity on a large scale, but few observations of Zn and Mn have been made. This proposal seeks to map bioavailable Zn concentrations across an oceanographic transect from the South Pacific Ocean to the Amundsen Sea. At low abundance, Zn scarcity can limit phytoplankton, but Zn can also affect the uptake of other scarce metals, especially Mn. Measurements made as part of this project will determine the extent of limiting and toxic levels of Zn in this critical but undersampled region of the oceans. Such constraints are necessary for modelling changes to the oceanic Zn cycle – and its effect on phytoplankton activity – under past and future climate scenarios.

As part of the GEOTRACES GP17 OCE and ANT expeditions, parameters governing the reactivity of Zn will be measured in high vertical and latitudinal resolution across a transect extending several thousand kilometers and crossing formation regions of globally important water masses. Voltammetry techniques will be used to determine the concentrations of free zinc (Zn’) and Zn-binding organic ligands dissolved in seawater for hundreds of samples. Together with other investigators in the GEOTRACES program, these measurements will constrain the reactivity of Zn’ in the deep ocean and define empirical relationships between Zn’ and phytoplankton metal uptake. This is essential for understanding the global distribution of Zn and other micronutrients in the oceans and their potential to affect primary production.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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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-2049151

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