Nitrous oxide (N2O) isotopes and concentrations from the U.S. GEOTRACES EPZT cruise (GP16, TN303) on R/V Thomas G. Thompson in the tropical Pacific from October to December 2013

Website: https://www.bco-dmo.org/dataset/933645
Data Type: Cruise Results
Version: 1
Version Date: 2024-07-24

Project
» U.S. GEOTRACES East Pacific Zonal Transect (GP16) (U.S. GEOTRACES EPZT)
» GEOTRACES Peru-Tahiti Nitrogen Isotope Measurements (EPZT Nitrogen Isotopes)

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

Contributors	Affiliation	Role
Casciotti, Karen L.	Stanford University	Principal Investigator
Gluschankoff, Noah	Stanford University	Student
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset includes nitrous oxide (N2O) isotopes and concentration measurements with accompanying physiochemical data from the 2013 U.S. GEOTRACES East Pacific Zonal Transect cruise (GP16). The cruise sailed from October 25, 2013 to December 18, 2023 aboard the R/V Thompson.

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Coverage

Spatial Extent: **N**:-10.5 **E**:-77.38 **S**:-16 **W**:-152
Temporal Extent: 2013-10-29 - 2013-12-18

Methods & Sampling

Water samples were collected at discrete depths using Niskin bottle type rosette samplers and an SBE9plus conductivity-temperature-depth (CTD) sensor package (SeaBird Electronics, Bellevue, WA). This dataset's samples were collected from Niskin bottles into 160-milliliter (mL) glass serum vials, killed with saturated mercuric chloride, and crimp sealed with gray butyl stoppers. Prior to sealing, ~1 mL of sample was removed to allow room for sample expansion and to prevent the sample vessel from shattering upon warming.

In all cases, samples were extracted and analyzed using a custom automated purge and trap inlet system and normalized to an injection of calibrated pure N2O reference gas introduced prior to the elution of each sample peak (McIlvin & Casciotti, 2010). Isotope ratios were referenced initially to the calibrated N2O reference tank to create a set of 'ratio of ratios' (^{31}Rsample/^{31}Rreference, ^{45}Rsample/^{45}Rreference, ^{46}Rsample/^{46}Rreference). Next, the data were size corrected in reference to a calibrated 20 volt-second (Vs) peak area for a mass-to-charge ratio of 44 (m/z 44). The size-corrected data were then corrected using a log-scaled normalization based on three isotopically distinct reference materials with known isotopocule compositions that were analyzed alongside the seawater samples (Kelly et al. 2023). Finally, 'scrambling coefficients' were applied to the isotopomer data to correct the measured 15Ra and 15Rb for the rearrangement of nitrogen atoms in N2O when the gas is ionized in the mass spectrometer ion source (Frame et al., 2014; Frame & Casciotti, 2010; Kelly et al., 2021). The isotope ratios of N and O atoms in N2O, ^{15}Rsample or ^{18}Rsample, respectively, are expressed in delta notation (δ), where the δ15N and δ18O are defined relative to the isotope ratios of certified standards: δ15N or δ18O = (Rsample/Rstandard - 1) x1000. The Rstandard values used for δ15N and δ18O are the ratios of 15N/14N and 18O/16O in atmospheric N2 and Vienna Standard Mean Ocean Water (VSMOW), respectively.

Data Processing Description

CTD sensor data were processed using Seabird Electronics (SBE) Data Processing software using SBE recommended parameters, including the tau oxygen correction and oxygen hysteresis correction.

A quality control (QC) flag was also added for each measurement using the SeaDataNet QC guidelines available at https://www.seadatanet.org/Standards/Data-Quality-Control:

1 = good value;
2 = probably good value;
3 = probably bad value;
4 = bad value;
9 = missing value.

BCO-DMO Processing Description

- Imported original file "gp16_bco_dmo_avg_stdv_240619.csv" into the BCO-DMO system.
- Flagged "NaN" as a missing data value (missing data are empty/blank in the final CSV file).
- Converted DATE field to YYYY-MM-DD format.
- Renamed fields to comply with BCO-DMO naming conventions.
- Saved the final file as "933645_v1_gp16_n2o_isotopes_and_concentrations.csv".

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Data Files

File
933645_v1_gp16_n2o_isotopes_and_concentrations.csv (Comma Separated Values (.csv), 73.51 KB) MD5:1453172f5b1c43feb43f9e2c76c436ea Primary data file for dataset ID 933645, version 1

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Related Publications

Frame, C. H., & Casciotti, K. L. (2010). Biogeochemical controls and isotopic signatures of nitrous oxide production by a marine ammonia-oxidizing bacterium. Biogeosciences, 7(9), 2695–2709. https://doi.org/10.5194/bg-7-2695-2010
Methods

Frame, C. H., Deal, E., Nevison, C. D., & Casciotti, K. L. (2014). N2O production in the eastern South Atlantic: Analysis of N2O stable isotopic and concentration data. Global Biogeochemical Cycles, 28(11), 1262–1278. doi:10.1002/2013gb004790 https://doi.org/10.1002/2013GB004790
Methods

Kelly, C. L., Manning, C., Frey, C., Kaiser, J., Gluschankoff, N., & Casciotti, K. L. (2023). Pyisotopomer: A Python package for obtaining intramolecular isotope ratio differences from mass spectrometric analysis of nitrous oxide isotopocules. Rapid Communications in Mass Spectrometry, 37(11). Portico. https://doi.org/10.1002/rcm.9513
Methods

Kelly, C. L., Travis, N. M., Baya, P. A., & Casciotti, K. L. (2020). Quantifying nitrous oxide cycling regimes in the eastern tropical North Pacific Ocean with isotopomer analysis. Global Biogeochemical Cycles. doi:10.1029/2020gb006637 https://doi.org/10.1029/2020GB006637
Methods

McIlvin, M. R., & Casciotti, K. L. (2010). Fully automated system for stable isotopic analyses of dissolved nitrous oxide at natural abundance levels. Limnology and Oceanography: Methods, 8(2), 54–66. doi:10.4319/lom.2010.8.54
Methods

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Related Datasets

IsRelatedTo

Casciotti, K. L., Gluschankoff, N. (2024) **Nitrite (NO2-) isotopes and concentrations from the U.S. GEOTRACES EPZT cruise (GP16, TN303) on R/V Thomas G. Thompson in the tropical Pacific from October to December 2013.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-07-30 doi:10.26008/1912/bco-dmo.933707.1 [view at BCO-DMO]

Casciotti, K., Altabet, M. (2020) **Nitrate isotope data from R/V Thomas G. Thompson cruise TN303 in the Eastern Tropical Pacific in 2013 (U.S. GEOTRACES EPZT project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2016-06-24 doi:10.26008/1912/bco-dmo.650087.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
STNNBR	Station number	unitless
GEOTRC_EVENTNO	GEOTRACES event number	unitless
GEOTRC_SAMPNO	GEOTRACES sample number	unitless
DATE	Date of sampling	unitless
LATITUDE	Latitude; South is negative	decimal degrees
LONGITUDE	Longitude; West is negative	decimal degrees
CTDPRS	Pressure	decibars
DEPTH	Depth	meters (m)
CTDTMP	Temperature	degrees Celsius
CTDSAL	Salinity	PSU
N2O_ALPHA_15_14_D_DELTA_BOTTLE_mmz7wk	Average d15N alpha (inner nitrogen atom) in N2O in reference to atmospheric nitrogen gas, expressed in permille notation. (Code at the end of column name is GEOTRACES DOoR identifier.)	permille
SD1_N2O_ALPHA_15_14_D_DELTA_BOTTLE_mmz7wk	Standard deviation d15N alpha (inner nitrogen atom) in N2O in reference to atmospheric nitrogen gas, expressed in permille notation. (Code at the end of column name is GEOTRACES DOoR identifier.)	permille
N2O_BETA_15_14_D_DELTA_BOTTLE	Average d15N beta (outer nitrogen atom) in N2O in reference to atmospheric nitrogen gas, expressed in permille notation.	permille
SD1_N2O_BETA_15_14_D_DELTA_BOTTLE	Standard deviation d15N beta (outer nitrogen atom) in N2O in reference to atmospheric nitrogen gas, expressed in permille notation.	permille

N2O_SP_15_14_D_DELTA_BOTTLE	Average N2O SP (site preference) in N2O in reference to atmospheric nitrogen gas, expressed in permille notation.	permille
SD1_N2O_SP_15_14_D_DELTA_BOTTLE	Standard deviation N2O SP (site preference) in N2O in reference to atmospheric nitrogen gas, expressed in permille notation.	permille
N2O_15_14_D_DELTA_BOTTLE_f2vswm	Average d15N bulk in N2O in reference to atmospheric nitrogen gas, expressed in permille notation. (Code at the end of column name is GEOTRACES DOoR identifier.)	permille
SD1_N2O_15_14_D_DELTA_BOTTLE_f2vswm	Standard deviation d15N bulk in N2O in reference to atmospheric nitrogen gas, expressed in permille notation. (Code at the end of column name is GEOTRACES DOoR identifier.)	permille
N2O_17_16_D_DELTA_BOTTLE	Average d17O in N2O in reference to VSMOW, expressed in permille notation	permille
SD1_N2O_17_16_D_DELTA_BOTTLE	Standard deviation d17O in N2O in reference to VSMOW, expressed in permille notation	permille
N2O_18_16_D_DELTA_BOTTLE_xkal8d	Average d18O in N2O in reference to VSMOW, expressed in permille notation. (Code at the end of column name is GEOTRACES DOoR identifier.)	permille
SD1_N2O_18_16_D_DELTA_BOTTLE_xkal8d	Standard deviation d18O in N2O in reference to VSMOW, expressed in permille notation. (Code at the end of column name is GEOTRACES DOoR identifier.)	permille
N2O_D_CONC_BOTTLE_ahlf1q	Average N2O concentration measurement in nanomolar (nmol/L). (Code at the end of column name is GEOTRACES DOoR identifier.)	nanomolar (nmol/L)
SD1_N2O_D_CONC_BOTTLE_ahlf1q	Error in N2O concentration measurement in nanomolar (nmol/L). (Code at the end of column name is GEOTRACES DOoR identifier.)	nanomolar (nmol/L)
N2O_Flag	N2O isotope and concentration measurement data quality control flag from SeaDataNet: 1 = good value; 2 = probably good value; 3 = probably bad value; 4 = bad value; 9 = missing value.	unitless
CASTNO	Cast number	unitless
OXYGEN	Oxygen concentration	micromoles per kilogram (umol/kg)
SILCATE	Silicate concentration	micromoles per kilogram (umol/kg)
NITRATE	Nitrate Concentration	micromoles per kilogram (umol/kg)
NITRITE	Nitrite Concentration	micromoles per kilogram (umol/kg)
PHOSPHATE	Phosphate Concentration	micromoles per kilogram (umol/kg)

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Instruments

Dataset-specific Instrument Name	custom automated purge and trap inlet system
Generic Instrument Name	Automated Purge and Trap System
Dataset-specific Description	This equipment removes dissolved gases from the water samples, traps the extracted compounds on a cold trap and then heats the trap and injects the trapped gases into the gas chromatograph. It is automated and controlled by a laptop computer.
Generic Instrument Description	This equipment removes dissolved gases from the water samples, traps the extracted compounds on a cold trap and then heats the trap and injects the trapped gases into the gas chromatograph. It is automated and controlled by a laptop computer.

Dataset-specific Instrument Name	SBE9plus conductivity-temperature-depth (CTD) sensor package (SeaBird Electronics, Bellevue, WA)
Generic Instrument Name	CTD Sea-Bird
Generic Instrument Description	A Conductivity, Temperature, Depth (CTD) sensor package from SeaBird Electronics. This instrument designation is used when specific make and model are not known or when a more specific term is not available in the BCO-DMO vocabulary. Refer to the dataset-specific metadata for more information about the specific CTD used. More information from: http://www.seabird.com/

Dataset-specific Instrument Name	Thermo Fisher Delta V Plus Isotope Ratio Mass Spectrometer
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	Niskin bottle type rosette samplers
Generic Instrument Name	Niskin bottle
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

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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/

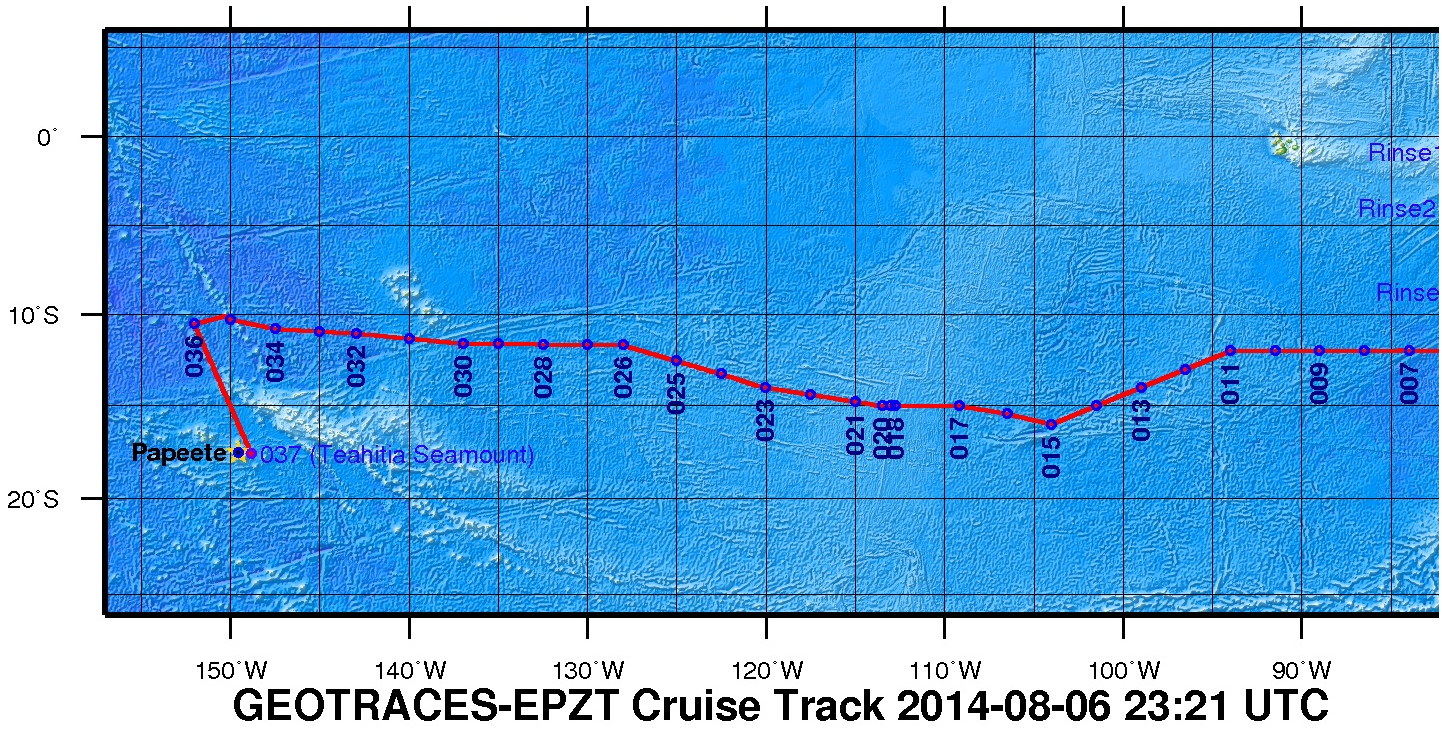
Coverage: Eastern Tropical Pacific - Transect from Peru to Tahiti (GP16)

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 Peru-Tahiti Nitrogen Isotope Measurements (EPZT Nitrogen Isotopes)

Coverage: East Pacific Zonal Transect

Description from NSF award abstract:
Nitrogen (N) is an essential macronutrient whose availability can limit primary production and the capacity of the biological pump to export carbon from the surface ocean on seasonal, annual, decadal, and millennial timescales. The inventory of fixed (bioavailable) N in the ocean is driven by biological processes such as nitrogen fixation, denitrification, and anaerobic ammonia oxidation (anammox). Water column oxygen deficient zones (ODZs) are important sites for fixed N loss, as well as N2O production, and they are projected to expand and intensify in the coming years as global warming increases ocean stratification and decreases ventilation. It is important to understand the distribution of nitrate, nitrite, and N2O isotopes in relation to current ocean conditions of oxygen and trace element availability order to interpret past and future changes in nitrate signals.

In this project, a team of researchers from Stanford University, University of Massachusetts at Dartmouth, and Brown University will measure the nitrogen- and oxygen-isotopic composition (del15N and del18O) of nitrate, nitrite, and nitrous oxide in seawater samples collected along the GEOTRACES Pacific Peru-Tahiti Section. Values of del15N and del18O will also be measured in nitrate from aerosol and rain samples to inform our interpretation of the N isotope budget and isotopic gradients within the tropical South Pacific. Finally, N2/Ar and N2 del15N will be determined to close the N mass and isotope budgets. Nitrate del15N is a GEOTRACES "core parameter" that will complement other measurements, such as bioactive trace element concentrations and speciation, Si isotope variations, as well as redox and productivity proxies.

The GEOTRACES Peru-Tahiti section provides a rare opportunity to track the fate of the isotopic signals of N loss from one of the largest water column ODZs. Furthermore, little is known about the effect of N recycling through hydrothermal vents on nitrate isotopes in the deep ocean, and this section will allow quantitative tracking of this input. Together, these measurements will yield insight into the relative rates of modern N cycle processes and will provide background information for paleoceanographic applications.

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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-1233339

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