

Concentrations of soluble and dissolved iron (Fe) and iron isotope ratios from the U.S. GEOTRACES EPZT cruise (GP16, TN303) on R/V Thomas G. Thompson in the tropical Pacific during November & December 2013

Website: <https://www.bco-dmo.org/dataset/818707>

Data Type: Cruise Results

Version: 1

Version Date: 2020-07-16

Project

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

» [GEOTRACES: Suspended particle geochemistry along the US GEOTRACES Eastern Pacific Zonal Transect, from high productivity ocean margin to deep sea hydrothermal plume](#) (GEOTRACES EPZT Suspended Particles)

Program

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

Contributors	Affiliation	Role
Fitzsimmons, Jessica N.	Texas A&M University (TAMU)	Principal Investigator
Conway, Timothy M.	University of South Florida (USF)	Co-Principal Investigator
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Abstract

Concentrations of soluble and dissolved iron (Fe) and iron isotope ratios from the U.S. GEOTRACES EPZT cruise (GP16, TN303) on R/V Thomas G. Thompson in the tropical Pacific during November & December 2013.

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Coverage

Spatial Extent: N:-11.671 E:-112.75 S:-15 W:-128

Temporal Extent: 2013-11-21 - 2013-12-04

Acquisition Description

Sample Collection and Filtration

All seawater samples analyzed here for dissolved iron (dFe) concentration and isotope ratios ($\delta^{56}\text{Fe}$) were collected between 21 November and 4 December 2013 aboard the R/V Thomas G. Thompson as part of the U.S. GEOTRACES GP16 East Pacific Zonal Transect (Resing et al. 2015, Fitzsimmons et al. 2017, John et al. 2018). The EPZT encompassed 35 stations along an 8000 km transect that traversed from Peru to Tahiti (Peters et al. 2017, Moffett & German 2018). All seawater samples were collected as part of the standard U.S. GEOTRACES trace metal casts, using a trace metal clean carousel and CTD (Seabird) with a Kevlar conducting cable, fitted with 24 x 12-L Teflon-coated GO-Flo bottles (General Oceanics), following established GEOTRACES protocols (Cutter & Bruland 2012). Rosette deployments began with GO-Flo bottles open, allowing them to flush during deployment to depth, and the GO-Flo bottle was subsequently tripped on ascent at ~ 3 m/min, to minimize chances of contamination from rosette hardware. Upon recovery, GO-Flo bottles were transferred immediately into a clean van for subsampling and were pressurized using HEPA-filtered air. Each GO-Flo bottle was fitted with acid-cleaned Teflon tubing connected to a 0.2 μm Acropak-200 capsule filter (Pall), allowing collection of filtered seawater for bulk dissolved Fe analysis into 4 L acid-clean low-density polyethylene (LDPE) bottles, after three 10% volume seawater rinses of the caps and threads (Cutter et al. 2017). Filtered seawater from Station 26 at 2650 m and 2700 m depths were combined to achieve sufficient volume for ultrafiltration processing.

Ultrafiltration and Sample Processing

Immediately after sample collection and 0.2 μm filtration, 1 L of the 4 L homogenized sample was poured into a clean 1 L LDPE bottle for dissolved Fe analysis, and the remaining sample (~ 3 L) was ultrafiltered. Ultrafiltration took place using a cross flow filtration system (CFF) with a 10 kDa (~ 0.003 μm for globular proteins; Erickson et al. 2009) regenerated cellulose membrane (Pellicon XL PLCGC) in single-pass mode (see Fitzsimmons and Boyle 2014 for detailed methods). Briefly, before collection, the CFF system was conditioned using ~ 500 mL of sample seawater, and the sample bottles, caps, and threads were rinsed with a minimal amount of ultrafiltered seawater. After conditioning, ~ 1 L of permeate (soluble fraction) and ~ 1 L of retentate were collected into separate 1 L LDPE bottles. All samples were then acidified to 0.012 M hydrochloric acid (HCl, Optima, Fisher) and stored for more than a year before analysis. Soluble Fe (sFe) is defined as the concentration in the permeate solution.

Dissolved Fe Concentration Analysis

Iron concentrations in the dissolved, permeate, and retentate phases were analyzed using a 15 mL aliquot of the 1 L samples. Samples were analyzed in the Sherrell lab at Rutgers University with a SeaFAST pico system (ESI, Omaha, NE, USA) and Thermo Element 1 HR-ICPMS following the SeaFAST methods of Lagerstrom et al. (2013). Samples were analyzed offline, as outlined by Jensen et al. (2020).

Dissolved Fe isotope ratio ($\delta^{56}\text{Fe}$) Analysis

Iron stable isotope ratios ($\delta^{56}\text{Fe}$) were determined using a double-spike multi-collector MC-ICPMS technique, based on Conway *et al.* (2013). All sample processing and Fe isotope analyses were carried out at the University of South Florida (USF). Chemical processing of samples took place in ISO-5 laminar flow hoods within the Marine Metal Isotope and Trace Element ISO-6 clean laboratory at the USF College of Marine Science. All ultrapure water used was from a Thermo Scientific Barnstead Genpure Ultrapure Water System; all plasticware was cleaned using standard procedures (Conway et al. 2013); and all reagents were Optima grade from Fisher Scientific. Briefly, the ~ 1 L of dissolved, permeate, and retentate seawater samples were spiked with a double spike containing ^{57}Fe and ^{58}Fe at a ratio of $\sim 1:1$, to provide a $\sim 1:2$ ratio of natural:spike Fe in samples. Following spiking, samples were amended to 10 mM H_2O_2 and left for 24 h after spiking. Samples were then brought to pH ~ 6 , and Fe was extracted from seawater onto Nobias PA-1 chelating resin beads using a batch extraction technique. The Fe was then eluted from the Nobias resin using 3 M HNO_3 , evaporated to dryness, refluxed with a conc. HNO_3 and conc. H_2O_2 mixture, evaporated to dryness, taken up in 1 M HCl, and purified using an AGMP-1 (BioRad) anion-exchange column chemistry technique following Sieber *et al.* (2019). Following column purification, samples were

evaporated to dryness before being re-dissolved in 0.5 mL of 2% HNO₃ (v/v) for analysis by MC-ICPMS.

Samples were analyzed for Fe isotope ratios by Thermo Neptune Plus MC-ICPMS at USF's Tampa Bay Plasma Facility at the USF College of Marine Science. Briefly, samples were introduced via a ~100 µL/min PFA nebulizer into an ESI Apex Ω desolvator (with Ar but no N₂ add gas), using a Ni Jet sampler cone and an Al X skimmer cone. Fe isotope ratios were measured using high resolution mode, and instrumental mass bias was corrected using the double spike technique. δ⁵⁶Fe were calculated following an iterative procedure based on Siebert *et al.* (2001) and are expressed relative to the IRMM-014 international standard.

Problem report: Filtered seawater from Station 26 at 2650 m and 2700 m depths were combined to achieve sufficient volume for ultrafiltration processing.

Processing Description

Dissolved Fe Concentration Data Processing

The raw counts from the Element 1 analyses were first corrected for any instrument blank derived from a 10% nitric acid and In solution repeatedly analyzed during the instrumental session. Following this, each sample was corrected for machine drift and variation in instrumental sensitivity during analysis using the added ¹¹⁵In as well as instrument mass bias using an Fe elemental standard. Subsequently, all counts for isotope spiked elements were converted to concentration in nmol/kg based on the weight of the sample and known concentrations of the added isotope spike mixture. For every 40 seawater samples at least 24 "Procedure blanks" were included throughout the run. These process blanks consisted of freshly acidified ultrapure water spiked with a diluted version of the isotope spike mixture. Each blank was processed identically to a sample in an attempt to account for contamination coming from solutions (buffer, eluent) used or the SeaFAST itself. After conversion to concentration units, the most consistent procedure blank values for each metal are used to subtract an average procedure blank from all sample concentrations determined during that run. Each run, an internal standard was analyzed six times and an external standard (such as SAFe water) was analyzed two times as a "check" of our long-term precision and accuracy.

For the session in which these samples were analyzed, accuracy of the technique was assessed using analyses of SAFe consensus seawater solutions during the analytical session: SAFe S = 0.13 nmol/kg (consensus value 0.093±0.008 nmol/kg), SAFe D1 = 0.73 nmol/kg (consensus value of 0.67±0.04 nmol/kg), and SAFe D2 = 0.95 nmol/kg (compared to consensus value of 0.933±0.023 nmol/kg). An error of 5% is reported on all concentration values, based on the long-term external reproducibility of an in-house seawater solution. Dissolved Fe concentrations compared well with published dissolved Fe concentrations (Fitzsimmons *et al.* 2017, John *et al.* 2018) from the GP16 section reported in the Intermediate Data Product (IDP) 2017 (Schlitzer *et al.* 2018).

Dissolved Fe isotope ratio (δ⁵⁶Fe) Data Processing

To account for any instrumental drift during the analytical session, each group of five samples was expressed relative to the average δ⁵⁶Fe of two bracketing IRMM-014 double spike mixtures. The validity of this method for generating precise and accurate seawater δ⁵⁶Fe data has been shown previously by several inter-laboratory inter-comparison exercises, as well as repeated analysis of seawater and standard reference materials (Conway *et al.* 2013). At USF, precision and accuracy of δ⁵⁶Fe measurements are based on the long-term analysis of a 100 ng g⁻¹ NIST 3126a Fe standard (+0.36±0.04‰, n=190 over 2 years). Following that approach, we apply 0.04‰ as a conservative 2SD measure of uncertainty on all δ⁵⁶Fe data presented here, except if the standard internal error (2SD) is larger. In those cases, which typically occur at lower sample Fe concentrations, the 2SD is taken as a more conservative estimate of error and is used instead. Dissolved δ⁵⁶Fe measurements made during this study compared well with previously reported data measured on separate subsamples in another laboratory (John *et al.* 2018), and when direct depth comparisons were not available we compared to the mean of bracketed sampling depths. 100% of measurements taken at the same depth were within error of one another, while 83% of all δ⁵⁶Fe measurements were within error across the two studies (including samples compared to bracketed depth means).

Quality Flags:

Data were flagged using the SeaDataNet quality flag scheme. For more information on SeaDataNet flags, see: <https://www.seadatanet.org/Standards/Data-Quality-Control>

SeaDataNet quality flag definitions:

0 = No quality control;

1 = Good value;

2 = Probably good value;

3 = Probably bad value;

4 = Bad value;

5 = Changed value;

6 = Value below detection;

7 = Value in excess;

8 = Interpolated value;

9 = Missing value;

A = Value phenomenon uncertain.

BCO-DMO Processing:

- added ISO_DateTime_UTC column.

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Related Publications

Conway, T. M., Rosenberg, A. D., Adkins, J. F., & John, S. G. (2013). A new method for precise determination of iron, zinc and cadmium stable isotope ratios in seawater by double-spike mass spectrometry. *Analytica Chimica Acta*, 793, 44–52. doi:[10.1016/j.aca.2013.07.025](https://doi.org/10.1016/j.aca.2013.07.025)

Methods

Cutter, G. A., & Bruland, K. W. (2012). Rapid and noncontaminating sampling system for trace elements in global ocean surveys. *Limnology and Oceanography: Methods*, 10(6), 425–436.

doi:[10.4319/lom.2012.10.425](https://doi.org/10.4319/lom.2012.10.425)

Methods

Cutter, G., Casciotti, K., Croot, P., Geibert, W., Heimbürger, L.-E., Lohan, M., Planquette, H., & Van De Fliedert, T. (2017). Sampling and Sample-handling Protocols for GEOTRACES Cruises. Version 3, August 2017. GEOTRACES International Project Office. <https://doi.org/10.25607/OBP-2>

Methods

Erickson, H. P. (2009). Size and Shape of Protein Molecules at the Nanometer Level Determined by Sedimentation, Gel Filtration, and Electron Microscopy. *Biological Procedures Online*, 11(1), 32–51.

doi:[10.1007/s12575-009-9008-x](https://doi.org/10.1007/s12575-009-9008-x)

Methods

Fitzsimmons, J. N., & Boyle, E. A. (2014). Assessment and comparison of Anopore and cross flow filtration methods for the determination of dissolved iron size fractionation into soluble and colloidal phases in seawater. *Limnology and Oceanography: Methods*, 12(4), 246–263. doi:[10.4319/lom.2014.12.246](https://doi.org/10.4319/lom.2014.12.246)

Methods

Fitzsimmons, J. N., John, S. G., Marsay, C. M., Hoffman, C. L., Nicholas, S. L., Toner, B. M., ... Sherrell, R. M. (2017). Iron persistence in a distal hydrothermal plume supported by dissolved–particulate exchange. *Nature Geoscience*, 10(3), 195–201. doi:[10.1038/ngeo2900](https://doi.org/10.1038/ngeo2900)

doi:[10.1038/ngeo2900](https://doi.org/10.1038/ngeo2900)

Related Research

Jensen, L. T., Wyatt, N. J., Landing, W. M., & Fitzsimmons, J. N. (2020). Assessment of the stability, sorption, and exchangeability of marine dissolved and colloidal metals. *Marine Chemistry*, 220, 103754.

doi:[10.1016/j.marchem.2020.103754](https://doi.org/10.1016/j.marchem.2020.103754)

Methods

John, S. G., Helgoe, J., Townsend, E., Weber, T., DeVries, T., Tagliabue, A., ... Till, C. (2018).

Biogeochemical cycling of Fe and Fe stable isotopes in the Eastern Tropical South Pacific. *Marine Chemistry*, 201, 66–76. doi:[10.1016/j.marchem.2017.06.003](https://doi.org/10.1016/j.marchem.2017.06.003)

Related Research

Kipp, L. E., Sanial, V., Henderson, P. B., van Beek, P., Reyss, J.-L., Hammond, D. E., ... Charette, M. A. (2018). Radium isotopes as tracers of hydrothermal inputs and neutrally buoyant plume dynamics in the deep ocean. *Marine Chemistry*, 201, 51–65. doi:[10.1016/j.marchem.2017.06.011](https://doi.org/10.1016/j.marchem.2017.06.011)

General

Lagerström, M. E., Field, M. P., Séguret, M., Fischer, L., Hann, S., & Sherrell, R. M. (2013). Automated on-line flow-injection ICP-MS determination of trace metals (Mn, Fe, Co, Ni, Cu and Zn) in open ocean seawater: Application to the GEOTRACES program. *Marine Chemistry*, 155, 71–80.

doi:[10.1016/j.marchem.2013.06.001](https://doi.org/10.1016/j.marchem.2013.06.001)

Methods

Marsay, C. M., Lam, P. J., Heller, M. I., Lee, J.-M., & John, S. G. (2018). Distribution and isotopic signature of ligand-leachable particulate iron along the GEOTRACES GP16 East Pacific Zonal Transect. *Marine Chemistry*, 201, 198–211. doi:[10.1016/j.marchem.2017.07.003](https://doi.org/10.1016/j.marchem.2017.07.003)

General

Moffett, J. W., & German, C. R. (2018). The U.S. GEOTRACES Eastern Tropical Pacific Transect (GP16). *Marine Chemistry*, 201, 1–5. doi:[10.1016/j.marchem.2017.12.001](https://doi.org/10.1016/j.marchem.2017.12.001)

General

Peters, B. D., Jenkins, W. J., Swift, J. H., German, C. R., Moffett, J. W., Cutter, G. A., ... Casciotti, K. L. (2018). Water mass analysis of the 2013 US GEOTRACES eastern Pacific zonal transect (GP16). *Marine Chemistry*, 201, 6–19. doi:[10.1016/j.marchem.2017.09.007](https://doi.org/10.1016/j.marchem.2017.09.007)

General

Resing, J. A., Sedwick, P. N., German, C. R., Jenkins, W. J., Moffett, J. W., Sohst, B. M., & Tagliabue, A. (2015). Basin-scale transport of hydrothermal dissolved metals across the South Pacific Ocean. *Nature*, 523(7559), 200–203. doi:[10.1038/nature14577](https://doi.org/10.1038/nature14577)

Related Research

Roshan, S., DeVries, T., Wu, J., John, S., & Weber, T. (2020). Reversible scavenging traps hydrothermal iron in the deep ocean. *Earth and Planetary Science Letters*, 542, 116297.

doi:[10.1016/j.epsl.2020.116297](https://doi.org/10.1016/j.epsl.2020.116297)

General

Schlitzer, R., Anderson, R. F., Dodas, E. M., Lohan, M., Geibert, W., Tagliabue, A., ... Landing, W. M. (2018). The GEOTRACES Intermediate Data Product 2017. *Chemical Geology*, 493, 210–223.

doi:[10.1016/j.chemgeo.2018.05.040](https://doi.org/10.1016/j.chemgeo.2018.05.040)

Results

Sieber, M., Conway, T. M., de Souza, G. F., Obata, H., Takano, S., Sohrin, Y., & Vance, D. (2019). Physical and biogeochemical controls on the distribution of dissolved cadmium and its isotopes in the Southwest Pacific Ocean. *Chemical Geology*, 511, 494–509. doi:[10.1016/j.chemgeo.2018.07.021](https://doi.org/10.1016/j.chemgeo.2018.07.021)

Methods

Siebert, C., Nägler, T. F., & Kramers, J. D. (2001). Determination of molybdenum isotope fractionation by double-spike multicollector inductively coupled plasma mass spectrometry. *Geochemistry, Geophysics, Geosystems*, 2(7), n/a–n/a. doi:[10.1029/2000gc000124](https://doi.org/10.1029/2000gc000124)

Methods

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Parameters

Parameter	Description	Units
cruise	Cruise identifier	unitless
station_no	Station number	unitless
cast_no	Cast number	unitless
event_no	Event number	unitless
geotraces_no	GEOTRACES sample number	unitless
date	Sampling date (UTC); format: YYYY-MM-DD	unitless
time	Sampling time (UTC); format: hh:mm	unitless
ISO_DateTime_UTC	Sampling date and time (UTC) formatted to ISO8601 standard: YYYY-MM-DDThh:mmZ	unitless
lat	Latitude	decimal degrees North
long	Longitude	decimal degrees East
ctd_depth	Depth measured by CTD	meters (m)
dFe_conc	Dissolved Fe concentration (nanomoles per kilogram (nmol kg ⁻¹)
dFe_conc_error	1 std. deviation error on dissolved Fe concentration	nanomoles per kilogram (nmol kg ⁻¹)
dFe_conc_flag	Quality flag for dissolved Fe concentration (SeaDataNet scheme)	unitless
sFe_conc	Soluble Fe concentration (nanomoles per kilogram (nmol kg ⁻¹)
sFe_conc_error	1 std. deviation error on soluble Fe concentration	nanomoles per kilogram (nmol kg ⁻¹)
sFe_conc_flag	Quality flag for soluble Fe concentration (SeaDataNet scheme)	unitless
delta_56_dFe	Dissolved 56/54 Fe isotope ratio (per mil (‰)
delta_56_dFe_error	2 std. deviation error on dissolved 56/54 Fe isotope ratio	per mil (‰)
delta_56_dFe_flag	Quality flag for dissolved Fe isotope ratio (SeaDataNet scheme)	unitless
delta_56_sFe	Soluble 56/54 Fe isotope ratio (per mil (‰)
delta_56_sFe_error	2 std. deviation error on soluble 56/54 Fe isotope ratio	per mil (‰)
delta_56_sFe_flag	Quality flag for soluble Fe isotope ratio (SeaDataNet scheme)	unitless

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Instruments

Dataset-specific Instrument Name	Trace metal clean carousel and CTD (Seabird)
Generic Instrument Name	CTD Sea-Bird
Dataset-specific Description	Trace metal clean carousel and CTD (Seabird) with a Kevlar conducting cable, fitted with 24 x 12-L Teflon-coated GO-Flo bottles (General Oceanics), was used to collect water and depth measurements following established GEOTRACES protocols.
Generic Instrument Description	Conductivity, Temperature, Depth (CTD) sensor package from SeaBird Electronics, no specific unit identified. This instrument designation is used when specific make and model are not known. See also other SeaBird instruments listed under CTD. More information from Sea-Bird Electronics.

Dataset-specific Instrument Name	Thermo-Finnigan Element 1 HR-ICPMS
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Iron concentrations were analyzed in the Sherrell lab using a SeaFAST pico system (ESI, Omaha, NE, USA) and Thermo-Finnigan Element 1 HR-ICPMS following the SeaFAST methods of Lagerstrom et al., (2013).
Generic Instrument Description	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

Dataset-specific Instrument Name	Thermo Neptune Plus MC-ICPMS
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Samples were analyzed for Fe isotope ratios by Thermo Neptune Plus MC-ICPMS at USF's Tampa Bay Plasma Facility at the USF College of Marine Science.
Generic Instrument Description	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

Dataset-specific Instrument Name	Teflon-coated GO-Flo bottles (General Oceanics)
Generic Instrument Name	GO-FLO Teflon Trace Metal Bottle
Dataset-specific Description	A trace metal clean carousel and CTD (Seabird) with a Kevlar conducting cable, fitted with 24 x 12-L Teflon-coated GO-Flo bottles (General Oceanics), was used to collect water and depth measurements following established GEOTRACES protocols.
Generic Instrument Description	GO-FLO Teflon-lined Trace Metal free sampling bottles are used for collecting water samples for trace metal, nutrient and pigment analysis. The GO-FLO sampling bottle is designed specifically to avoid sample contamination at the surface, internal spring contamination, loss of sample on deck (internal seals), and exchange of water from different depths.

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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] Original data are available from the NSF R2R data catalog

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Project Information

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

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

Coverage: Eastern Tropical Pacific - Transect from Peru to Tahiti

From the NSF Award Abstract The mission of the International GEOTRACES Program (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 μM 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: Suspended particle geochemistry along the US GEOTRACES Eastern Pacific Zonal Transect, from high productivity ocean margin to deep sea hydrothermal plume (GEOTRACES EPZT Suspended Particles)

Coverage: Subtropical Southeastern Pacific Ocean

During the 2013 GEOTRACES Eastern Pacific cruise a diverse range of oceanic environments will be encountered from the high productivity/high particle flux waters off Peru to the Peru-Chile oxygen minimum zone, the hydrothermal plume of the East Pacific Rise, and finally to some of the most oligotrophic waters around Tahiti. Scientists from Rutgers University and Woods Hole Oceanographic Institution will sample suspended particulates from the same GO-Flo bottles that will be used to sample dissolved trace metals and their isotopes (TEIs) across this entire transect. The suspended matter samples will be analyzed for 42 elements, including the particle-reactive rare earth elements. In addition, core-top sediments will be collected at every water-column sampling station and analyzed for both bulk composition (i.e., relative % content of organic carbon, opal, biogenic carbonate and lithogenic components) and the same 42 elements to be analyzed in the suspended particulates. Results from this study will be used to assess the role of suspended particulates in the biogeochemical cycling of TEIs across the Eastern Pacific by addressing three key sets of questions: (1) How does uptake of TEIs into phytoplankton and non-living particles in the upper ocean drive the suspended particulate composition through the deeper water column, along the substantial gradient from the high productivity Peru margin to the oligotrophic ocean

interior?; (2) How faithfully is the along-transect variability in the upper ocean transmitted to the sediment (paleo) record?; (3) What are the relative influences of vertical recycling versus lateral advection in generating the distributions of dissolved and particulate TEIs observed in the Peru-Chile OMZ?; (4) Is there a characteristic signature of OMZ activity that is preserved in core-top sediments?; (5) What dominates TEI uptake onto/into authigenic particles in hydrothermal plumes and to what extent are these processes augmented by continuing uptake in core-top sediments?; and (6) What is the net effect from submarine venting on global TEI budgets? As regards broader impacts, the scientist from Rutgers University is collaborating with the Education Director of the Centers for Ocean Science Education Excellence Networked Ocean World (COSEE-NOW) to contribute to the MARE (Marine Activities, Resources, and Education) program by inviting teachers and high school students to workshops and presentations on climate and ocean sciences. With the help of COSEE-NOW, he also plans to create educational video clips during the Pacific cruise and the subsequent laboratory based analytical work to educate them on the use of geochemistry to understand how the ocean works. Both scientists also plan to develop a teaching module entitled "Particles, Metals, and Carbon" for an Introduction to Oceanography class taught by the Rutgers scientist. One postdoc from Rutgers University would be supported and trained as part of this project.

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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-1234827
NSF Division of Ocean Sciences (NSF OCE)	OCE-1713677
NSF Division of Ocean Sciences (NSF OCE)	OCE-1434493

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