Small and large particulate Th and Pa samples from different depth profiles collected on R/V Thomas G. Thompson in the Eastern Tropical Pacific during 2013 (EPZT Th Pa project)

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Project
» U.S. GEOTRACES East Pacific Zonal Transect (GP16) (U.S. GEOTRACES EPZT)
» U.S. GEOTRACES Pacific Section: Analysis of 230Th, 232Th and 231Pa (EPZT_Th_Pa)

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

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Abstract
Small and large particulate Th and Pa samples from different depth profiles collected on R/V Thomas G. Thompson in the Eastern Tropical Pacific during 2013 (U.S. GEOTRACES EPZT project).

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Dataset Description

Depth profiles of seawater small and large particulate 232Th, 230Th, and 231Pa.

Methods & Sampling

Size-fractionated particles were collected using McLane Research in-situ pumps (WTS-LV) that had been modified to accommodate two flowpaths (Lam and Morris Patent pending). The wire-out was used to target depths during deployment, and a self-recording Seabird 19plus CTD deployed at the end of the line and RBR data loggers attached to three of the eight pumps were used to correct for actual depths during pumping.

Filter holders used were 142 mm-diameter “mini-MULVFS” style filter holders with two stages for two size fractions and multiple baffle systems designed to ensure even particle distribution and prevent particle loss (Bishop et al. 2012). One of two filter holder/flowpaths was loaded with a 51um Sefar polyester mesh prefilter followed by paired 0.8 um Pall Supor800 polyethersulfone filters. Each cast also had “dipped blank” filters deployed. These were the full filters sets (prefilter followed by paired Supor filters) sandwiched within a 1 um polyester mesh filter, loaded into perforated polypropylene containers, attached with plastic cable ties to a pump frame, and deployed. Dipped blank filters were exposed to seawater for the length of the deployment and processed and analyzed as regular samples, and thus functioned as full seawater process blanks. We analyzed either quarter (LDEO) or eighth (Minnesota) portions of the top and bottom filters from the “dipped” blank from 1 or more depths for all stations.

All filters and filter holders were acid leached prior to use according to methods recommended in the GEOTRACES sample and sample-handing Protocols (Geotraces 2010).

Analytical methods for particulate radionuclides:

LDEO:

Filters were folded into 60 mL Teflon jars and weighed aliquots of artificial isotope yield monitors 229Th (1 pg) and 233Pa (0.3-0.4 pg) and 7-8 mg dissolved Fe were added to each sample, which then sat overnight in 5 mL 16M HNO3 [All acids and bases used were Fisher Chemical OPTIMA grade or equivalent from Trace Metal grade acids re-distilled in a Savillex™ DST-1000 sub-boiling still]. The next day, the filters were heated for ~1 hour at 180 deg C, at which point 4-5 ml HClO4 was added and the hot plate temperature was increased to 220 deg C. Samples were heated until dense white fumes appeared. After 10-20 minutes, the samples were covered with a Teflon watch cover. After 30-60 minutes, rapid oxidation of the Supor material would occur, at which point the Supor material was almost completely broken down. The watch glasses were removed and beaker walls were rinsed down with 3 ml 8N HNO3. Ten drops of HF were added, and the samples were heated at 220 deg C until the HClO4 dried down to a viscous residue.

The sample residue was taken up in dilute HCl, and transferred to 50 mL centrifuge tubes with Milli-Q water rinses. Fifteen to 25 drops of NH4OH were added to raise pH to 8-8.5 when iron (oxy)hydroxide precipitated. This precipitate was then centrifuged, supernatant was decanted, and the precipitate was washed with Milli-Q H2O. These step were repeated. The precipitate was then dissolved in 12 M HCl, ready for a series of anion-exchange chromatography steps to purify Th and Pa, as outlined in Anderson et. al., 2012. The purified Th and Pa solutions were dried down at 180-220 deg C in the presence of 2 drops of HClO4 and taken up in 0.5 mL of 0.16 M HNO3/0.026 M HF for mass spectrometric analysis.

Concentrations of 232Th, 230Th and 231Pa were calculated by isotope dilution, relative to the calibrated tracers 229Th and 233Pa added at the beginning of sample processing. Analyses were carried out on a Thermo-Finnegan ELEMENT XR Single Collector Magnetic Sector ICP-MS, equipped with a high-performance Interface pump (Jet Pump), and specially-designed sample (X) and skimmer (Jet) cones to ensure the highest possible sensitivity. All measurements were made in low-resolution mode ($\Delta m/M \approx 300$), peak jumping in Escan mode across the central 5% of the flat-topped peaks. Measurements were made on a MasCom^TM SEM; 229Th, 230Th, 231Pa and 233Pa were measured in Counting mode, while the 232Th signals were large enough that they were measured in Analog mode. Two solutions of SRM129, a natural U standard, were run multiple times throughout each run. One solution was in a concentration range where 238U and 235U were both measured in counting mode, allowing us to determine the mass bias/amu (typical values varied from -0.01/amu to 0.03/amu). In the other, more concentrated solution, 238U was measured in Analog mode and 235U was measured in Counting mode, yielding a measurement of the Analog/Counting Correction Factor. These corrections assume that the mass bias and Analog Correction Factor measured on U isotopes can be applied to Th and Pa isotope measurements. Each sample measurement was bracketed by measurement of an aliquot of the run solution, used to correct for the instrumental background count rates. To correct for tailing of 232Th into the minor Th and Pa isotopes, a series of 232Th standards were run at concentrations bracketing the expected 232Th concentrations in the samples. The analysis routine for these standards was identical to the analysis routine for samples, so we could see the changing beam intensities at the minor masses as we increased the concentration of the 232Th standards. The 232Th count rates in our Pa fractions are quite small, reflecting mainly reagent blanks, compared to the 232Th signal intensity in the Th fraction. The regressions of 230Th, 231Pa, and 233Pa signals as a function of the 232Th signal in the standards was used to correct for tailing

of 232Th in samples.

In addition to laboratory procedural blanks (reagents/labware blanks) and periodic measurements of an intercalibrated working standard solution of 232Th, 230Th and 231Pa, SW STD 2010-1, referred to by Anderson et al. (2012), the participating labs also analyzed “dipped blank” filters, mentioned above, to determine the total blank, associated with the sample collection and handling in addition to the laboratory procedure. LDEO measured top and bottom dipped blanks separately, while UMN measured top and bottom dipped blanks together.

We pooled all procedural blank-corrected “dipped” blanks separately by institution to determine filter blank corrections. That is, the LDEO data were corrected by the LDEO average dipped blank values (both top and bottom included), while the UMN data were corrected by the UMN average dipped blank values. Averages for “Dipped” small particle filter blanks for a 1/4 filter fraction 232Th, 230Th, and 231Pa at LDEO were 21.52 +/- 19.32 pg, 1.17 +/- 0.9 fg, and 0.07 +/- 0.07 fg, respectively.

Further details on analysis of seawater particulate radionuclides are given by Anderson et al. (2012).

UMN:

Filters were folded into 30 mL Teflon beaker and weighed aliquots of the artificial isotope yield monitors 229Th and 233Pa. Filters were first completely submerged in 7N HNO3 acid combined with 10 drops HF, tightly covered with a Teflon threaded cap and heated for 10 hours at 200 deg F so that the particulate sample was dissolved/leached under pressure. The leach solution was then transferred to a second acid-cleaned Teflon beaker separate from the residual filter. Five drops of HClO4 were then added to the leach solution in the second beaker. The original beaker walls and caps were washed with small amounts of weak HNO3 and the resulting solution added to the second beaker. The solution was then dried down and was taken up in 2N HCl, and transferred to 15ml centrifuge tubes along with a 2N HCl rinse. One drop of dissolved Fe and six to nine drops of NH4OH were added to raise pH to 8-8.5 at which time iron (oxy)hydroxide precipitated. This precipitate was then centrifuged, decanted, washed with deionized H2O (>18 MΩ), centrifuged, and dissolved in 14M HNO3 and transferred to a Teflon beaker. It was then dried down and taken up in 7N HNO3 for anion-exchange chromatography using AG1-X8, 100-200 mesh resin and a polyethylene frit. Initial separation was done on Teflon columns (internal diameter ~ 0.35cm) with a ~0.55 ml column volume (CV). The sample was loaded in one CV of 7N HNO3, followed by 1.5 CV of 7N HNO3, 3 CV of 8N HCl (collect Th fraction), and 3 CV of 8N HCl combined with 0.015N HF (collect Pa fraction). The Pa and Th fractions were then dried down in the presence of 2 drops of HClO4 and taken up in 7N HNO3. They were each passed through second and third columns (each with ~0.55 ml column volumes) using similar elution schemes. The final Pa and Th fractions were then dried down in the presence of 2 drops of HClO4 and dissolved in weak nitric acid for analysis on the mass spectrometer.

Concentrations of 232Th, 230Th and 231Pa were calculated by isotope dilution using nuclide ratios determined on a Thermo-Finnigan Neptune mass spectrometer. All measurements were done using a peak jumping routine in ion counting mode on the discreet dynode multiplier behind the retarding potential quadrupole. A solution of 233U-236U tracer was run to determine the mass bias correction (assuming that the mass fractionation for Th and Pa are the same as for U). Each sample measurement was bracketed by measurement of an aliquot of a wash solution, used to correct for the instrument background count rates on the masses measured.

Particulate samples were analyzed in batches of 37 to 39. An aliquot of an intercalibrated working standard solution of 232Th, 230Th and 231Pa, SW STD 2010-1, was added to a separate acid-cleaned Teflon beaker along with weighed aliquots of 229Th spike and 233Pa spike. Spike and Standard were equilibrated for 3 days. The solution was then dried down and taken up in 7N HNO3 for anion-exchange chromatography using AG1-X8, 100-200 mesh resin and a polyethylene frit, and processed like a sample. In addition to laboratory procedural blanks (reagents/labware blanks), a number of “dipped blank” filters were also processed like samples, to determine the total blank, associated with the sample collection and handling, in addition to the laboratory procedure.

At UMN, averages for “Dipped” small particle filter blanks for a 1/8 filter fraction were 13.06 +/- 15.43 pg 232Th, 0.61 +/- 0.55 fg 230Th, and 0.05 +/- 0.05 fg 231Pa respectively. For large particles, the blanks for a 1/8 filter fraction were 11.89 +/- 9.90 pg 232Th, 0.57 +/- 0.60 fg 230Th, and 0.03 +/- 0.02 fg 231Pa.

Further details on Pa and Th analysis at the U. Minnesota laboratory are given in Shen et al. (2002, 2003, 2012), and Cheng et al. (2000, 2013).

Data Processing Description

The reported errors for radionuclide concentrations represent the propagation of one sigma errors based on the standard isotope ratios collected by ICP-MS, estimated error in the 229Th or 233Pa spike concentration, and the blank correction of the individual isotopes for each sample batch.

Individual uncertainties for thorium were calculated to include contributions from (a) blank correction using the variance of the blanks measured over the course of the analyses, (b) standard error of the ratios of the analysis (typically close to counting statistics) and (c) spike calibration. For Pa we also included assessment of the correction from the yield correction, mass bias and machine background. In order to assess the reproducibility of the procedure, repeat analyses were performed on the GEOTRACES 2010-1 standard (SW STD 2010-1). For standards run alongside EPZT particle samples at LDEO, the reproducibility for each isotope was 1.03% for 230Th, 1.12% for 232Th and 2.95% for 231Pa. For standards run alongside EPZT particle samples at UMN, the reproducibility for each isotope was 0.24% for 230Th, 0.6% for 232Th and 0.65% for 231Pa.

Data Reporting:

In some cases a sample was analyzed twice. The results of these replicated analyses are reported on separate lines in the data file.

BCO-DMO Data Processing Notes:

- Filled in blank cells with nd.
- Changed column names to comply with GEOTRACES and BCO-DMO standards.
- Added an ISO_DateTime_UTC column.

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Data Files

File
EPZT_Particulate_Th_Pa.csv (Comma Separated Values (.csv), 98.35 KB) MD5:f3b8e445de795375a86bc0e7ddc131cf Primary data file for dataset ID 676231

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Parameters

Parameter	Description	Units
cruise_id	Ships cruise designation	unitless
cruise_part	Leg of cruise	unitless
STNNBR	Station number	unitless
EVENT_LAT	Station latitude; N is positive	decimal degrees
EVENT_LON	Station longitude; E is positive	decimal degrees

DEPTH_MAX	Maximum depth of pump deployment	meters
CASTNO	Cast number within a station	unitless
GEOTRC_EVENTNO	GEOTRACES event number	unitless
DATE_START_EVENT	Date sample was collected; yyyymmdd	unitless
TIME_START_EVENT	Time sample was collected; hhmm	unitless
BTLNBR	Sample bottle designation	unitless
GEOTRC_SAMPNO	GEOTRACES sample number	unitless
lab	Analystical lab	unitless
Th_232_SP_CONC_PUMP	Small particulate Th-232 concentration	pmol/kg
Th_232_SP_CONC_PUMP_ERR	1 sigma error in small particulate Th-232	pmol/kg
Th_232_SP_CONC_PUMP_FLAG	Flag for small particulate Th-232	unitless
Th_230_SP_CONC_PUMP	Small particulate Th-230 concentration	uBq/kg
Th_230_SP_CONC_PUMP_ERR	1 sigma error in small particulate Th-230	uBq/kg
Th_230_SP_CONC_PUMP_FLAG	Flag for small particulate Th-230	unitless
Pa_231_SP_CONC_PUMP	Small particulate Pa-231 concentration	uBq/kg
Pa_231_SP_CONC_PUMP_ERR	1 sigma error in small particulate Pa-231	uBq/kg
Pa_231_SP_CONC_PUMP_FLAG	Flag for small particulate Pa-231	unitless
Th_232_LP_CONC_PUMP	Large particulate Th-232 concentration	pmol/kg
Th_232_LP_CONC_PUMP_ERR	1 sigma error in large particulate Th-232	pmol/kg
Th_232_LP_CONC_PUMP_FLAG	Flag for large particulate Th-232	unitless
Th_230_LP_CONC_PUMP	Large particulate Th-230 concentration	uBq/kg
Th_230_LP_CONC_PUMP_ERR	1 sigma error in large particulate Th-230	uBq/kg
Th_230_LP_CONC_PUMP_FLAG	Flag for large particulate Th-230	unitless
Pa_231_LP_CONC_PUMP	Large particulate Pa-231 concentration	uBq/kg
Pa_231_LP_CONC_PUMP_ERR	1 sigma error in large particulate Pa-231	uBq/kg
Pa_231_LP_CONC_PUMP_FLAG	Flag for large particulate Pa-231	unitless
Th_230_SP_ADS_CONC_PUMP	Small particulate adsorbed Th-230	uBq/kg
Th_230_SP_ADS_CONC_PUMP_ERR	1 sigma error in small particulate adsorbed Th-230	uBq/kg
Th_230_SP_XS_CONC_PUMP	Small particulate excess Th-230	uBq/kg
Th_230_SP_XS_CONC_PUMP_ERR	1 sigma error in small particulate excess Th-230	uBq/kg
Pa_231_SP_ADS_CONC_PUMP	Small particulate adsorbed Pa-231	uBq/kg

Pa_231_SP_ADS_CONC_PUMP_ERR	1 sigma error in small particulate adsorbed Pa-231	uBq/kg
Pa_231_SP_XS_CONC_PUMP	Small particulate excess Pa-231	uBq/kg
Pa_231_SP_XS_CONC_PUMP_ERR	1 sigma error in small particulate excess Pa-231	uBq/kg
Th_230_LP_ADS_CONC_PUMP	Large particulate adsorbed Th-230	uBq/kg
Th_230_LP_ADS_CONC_PUMP_ERR	1 sigma error in large particulate adsorbed Th-230	uBq/kg
Th_230_LP_XS_CONC_PUMP	Large particulate excess Th-230	uBq/kg
Th_230_LP_XS_CONC_PUMP_ERR	1 sigma error in large particulate excess Th-230	uBq/kg
Pa_231_LP_ADS_CONC_PUMP	Large particulate adsorbed Pa-231	uBq/kg
Pa_231_LP_ADS_CONC_PUMP_ERR	1 sigma error in large particulate adsorbed Th-230	uBq/kg
Pa_231_LP_XS_CONC_PUMP	Large particulate excess Pa-231	uBq/kg
Pa_231_LP_XS_CONC_PUMP_ERR	1 sigma error in large particulate excess Pa-231	uBq/kg

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Instruments

Dataset-specific Instrument Name	SeaBird 19Plus
Generic Instrument Name	CTD Sea-Bird
Dataset-specific Description	Used to collect samples and measurements
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	Niskin bottle
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Bottle used to collect water samples
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.

Dataset-specific Instrument Name	in situ pumps
Generic Instrument Name	Pump
Dataset-specific Description	Used to collected size fractioned particles
Generic Instrument Description	A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps

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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/

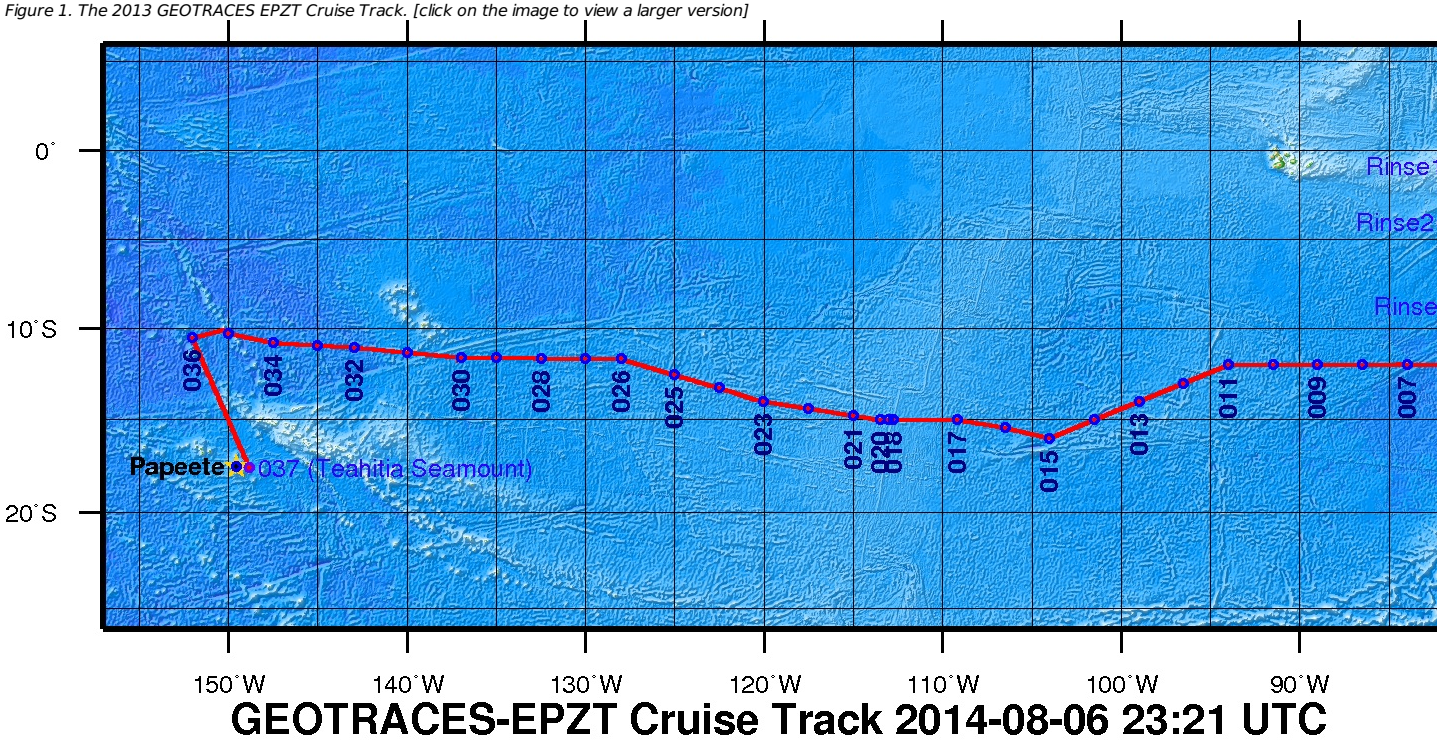
Coverage: Eastern Tropical Pacific - Transect from Peru to Tahiti (GP16)

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]



U.S. GEOTRACES Pacific Section: Analysis of 230Th, 232Th and 231Pa (EPZT_Th_Pa)

Coverage: Eastern Tropical South Pacific

The International GEOTRACES program is a multi-national effort to survey (by a series of cross-ocean sections) and understand the global-ocean distribution of trace elements and isotopes in seawater. The GEOTRACES Science Plan has designated the natural radioisotopes 231Pa and 230Th to be key parameters inasmuch as their measurement on all sections is deemed to be critical to the success of entire international ocean science program

In this project, a research team from the Lamont- Doherty Earth Observatory of Columbia University and the University of Minnesota - Twin Cities will undertake measurement of the dissolved and particulate concentrations of 230Th and 231Pa on the US GEOTRACES Peru-Tahiti section, one of the American contributions to the global GEOTRACES effort. Additionally, they will measure dissolved and particulate 232Th concentrations and analyze a limited number of aerosol samples, aerosol leachates, and surface sediments for these radionuclides. These data will be used to: 1) Quantify the rates of boundary scavenging of 231Pa and 230Th associated with the biologically productive Peru upwelling system, 2) Quantify the rates of bottom scavenging of 231Pa and 230Th thought to be associated with resuspended sediments in nepheloid layers, 3) Quantify the uptake of dissolved Th and Pa by metalliferous particles associated with the hydrothermal plume emanating from the East Pacific Rise as well as by authigenic particles formed within the oxygen minimum zone, 4) Quantify the supply of lithogenic 232Th from margin sediments by the combined study of 232Th and 230Th, and 5) Quantify the supply of lithogenic 232Th from aerosols by the combined study of 232Th and 230Th.

Through collaboration with other US GEOTRACES investigators, the team expects that this work will provide unprecedented constraints on the processes that supply trace elements to the ocean as well as the processes that remove them.

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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-1233688
NSF Division of Ocean Sciences (NSF OCE)	OCE-1233903

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