Particulate Th-234 from in-situ pumps, including large size fraction (> 51 um) and small size fraction (1-51 um), from R/V Thomas G. Thompson cruise TN303 in the Eastern Tropical Pacific in 2013 (U.S. GEOTRACES EPZT project)

Website: https://www.bco-dmo.org/dataset/643316
Data Type: Cruise Results
Version: 3
Version Date: 2020-06-11

Project
» U.S. GEOTRACES East Pacific Zonal Transect (U.S. GEOTRACES EPZT)
» US GEOTRACES Pacific Zonal Transect: Rates of supply, removal and internal cycling of trace elements and isotopes (EPZT TEI Rates)

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

Contributors	Affiliation	Role
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Abstract
Particulate Thorium-234 from in-situ pumps, including large size fraction (> 51 µm) and small size fraction (1-51 µm), during the 2013 U.S. GEOTRACES cruise.

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Coverage

Spatial Extent: **N**:-10.5 **E**:-77.376 **S**:-16 **W**:-152

Temporal Extent: 2013-10-29 - 2013-12-18

Dataset Description

Particulate Thorium-234 from in-situ pumps, including large size fraction (> 51 µm) and small size fraction (1-51 µm), during the 2013 U.S. GEOTRACES cruise.

Acquisition Description

Sampling details:
Super stations: approximately 24 discrete particulate Th-234 samples were collected throughout the water column.
Full stations: approximately 16 discrete particulate Th-234 samples were collected throughout the water column.
Hemi station: 8 discrete particulate Th-234 samples were collected from the upper 3000 m.
Demi and Shelf stations: no particulate samples were collected at the demi stations and the number of depths at the shelf stations was determined by the depth of the water column. Between 5 and 8 discrete particulate Th-234 samples were collected at the shelf stations.

Particulate material was collected using in situ McLane pumps (also see data from Charette and Lam groups). All data were decay corrected back to the mid-pumping times.

>51 um Th-234:
Mesh screens were provided by the Lam group. The whole mesh screen was rinsed onto a 25 mm silver filter and dried down. The mean volume pumped through the whole Supor mesh screens was 404 L.

1-51 um Th-234:
Whole QMAs, located below a mesh screen in the filter head housing, were provided by the Lam group and oven-dried upon recovery. A 25 mm subsample was taken from this whole filter for beta counting for Th-234. The mean effective volume for the 25 mm QMA subsample was 41 L (1042 L for entire QMA).

For more information on methods and intercalibration procedures, refer to the GEOTRACES Intercalibration Report (PDF) Supplemental File.

Processing Description

Detection Limits: Limits of detection are not reported because they are not applicable to the Th-234 beta counting method. A 'non-detect' for Th-234 or a case where there is no Th-234 present (initially or after 6 months of decay) will still result in a measurable amount of background radioactivity due to the beta decay of long-lived natural radionuclides that are also collected on the pump filters. These background values are utilized and therefore, they are not reported as a non-detection of Th-234.

Uncertainty: At the start and conclusion of each cruise, high activity U-238 standards and background counts (empty detectors) were measured to confirm correct operation of the RISØ detectors and to determine detector to detector variability. The reported uncertainty on each particulate Th-234 measurement represents the propagated counting uncertainty and detector to detector normalization. Counting uncertainty is generally the largest source of uncertainty so whenever possible samples were counted until errors were below 5%.

Inter-calibration Efforts: Results from the GEOTRACES Th-234 inter-calibration efforts are published in Maiti et al. (2012). Fifteen labs participated in two cruises that centered on particulate, total and dissolved Th-234 inter-calibration. Particulate Th-234 inter-calibration was assessed for small particles collected on QMAs and SUPORs, as well as for large particles collected on 51 um screens. Additional laboratory experiments were performed to understand the effects of filter type, flow rate, particle loading, and other

parameters on particulate Th-234 activity. Pertinent excerpts from Maiti et al. (2012) are included below:

'It is important to understand the inherent variability associated with initial sample collection and processing. The variability…may arise due to inter-filter variability, i.e., the variability associated with subsamples taken from the same filter, and inter-pump variability, i.e, the variability between pumps even when they are operating simultaneously for a fixed volume with similar flow-rates…Given the inter-pump and inter-filter variability, the inter-laboratory variability for both small and large particles appears to be reasonable. Overall, results from no laboratory was found to be consistently different from the mean 234Th activity reported for the inter-calibration exercise conducted on samples from stations with different particle types from the Atlantic (2008) and the Pacific (2009).'

'Particulate inter-calibration results indicate good agreement between all the participating labs with data from all labs falling within the 95% confidence interval around the mean for most instances. Filter type experiments indicate no significant differences in 234Th activities between filter types and pore sizes (0.2–0.8 μm). The only exception are the quartz filters, which are associated with 10% to 20% higher 234Th activities attributed to sorption of dissolved 234Th.'

'Overall, results from the current inter-calibration effort indicate that maximum variability can be expected in a high particle environment…Thus, for a station like SBB [Santa Barbara Basin], where fluxes can be measured from a typical six point profile in the upper 150 m of the water column, we can expect a maximum of 15% variability in the estimates between different laboratories based on our inter-calibration results. In comparison, we can expect good agreement in flux measurements amongst laboratories in an open ocean setting with lower 234Th deficiency.'

Because of the short half-life of Th-234 (~24 days), the nature of radionuclide analyses, and the high demand for particulate subsamples (the large size fraction in particular), inter-calibration between multiple labs was not possible during the 59-day GP16 cruise. However, the shallow, intermediate, and deep pump casts were made to overlap to provide some means of assessing cast to cast differences and reproducibility. While conditions can change during the duration of a pump cast (~4 hours) as well as from one cast to the next, noticeable differences (larger than expected for natural variability) in overlapping casts were only observed at one station during GP16. In addition, the same internal uranium standards were used by the Buesseler lab during the NAZT and EPZT GEOTRACES cruises and will continue to be used on future cruises. These standards provide a consistent means for calibration and comparison.

Problem reporting:
Empty fields denote that there were pump or filterhead issues that resulted in a compromised sample or no sample at this depth for either the QMA or screen or both. Data were flagged using the SeaDataNet quality flag scheme. For more information on SeaDataNet flags, see: https://www.geotraces.org/geotraces-quality-flag-policy/ and 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:
- renamed fields;
- added date/time fields in ISO8601 format;
- 11 June 2020: replaced with GEOTRACES DOoR-formatted/IDP version.

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Related Publications

Buesseler, K. O., Pike, S., Maiti, K., Lamborg, C. H., Siegel, D. A., & Trull, T. W. (2009). Thorium-234 as a tracer of spatial, temporal and vertical variability in particle flux in the North Pacific. Deep Sea Research Part I: Oceanographic Research Papers, 56(7), 1143–1167. doi:10.1016/j.dsr.2009.04.001
Methods

Maiti, K., Buesseler, K. O., Pike, S. M., Benitez-Nelson, C., Cai, P., Chen, W., … Xu, C. (2012). Intercalibration studies of short-lived thorium-234 in the water column and marine particles. Limnology and Oceanography: Methods, 10(9), 631–644. doi:10.4319/lom.2012.10.631
Methods

Owens, S. A., Pike, S., & Buesseler, K. O. (2015). Thorium-234 as a tracer of particle dynamics and upper ocean export in the Atlantic Ocean. Deep Sea Research Part II: Topical Studies in Oceanography, 116, 42–59. doi:10.1016/j.dsr2.2014.11.010
Methods

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Parameters

Parameter	Description	Units
Station_ID	Station number	unitless
Start_Date_UTC	Sampling start date (UTC); format: DD/MM/YYYY	unitless
Start_Time_UTC	Sampling start time (UTC); format: hh:mm	unitless
Start_ISO_DateTime_UTC	Sampling start date and time formatted to ISO8601 standard: YYYY-MM-DDThh:mmZ	unitless
End_Date_UTC	Sampling end date (UTC); format: DD/MM/YYYY	unitless
End_Time_UTC	Sampling end time (UTC); format: hh:mm	unitless
End_ISO_DateTime_UTC	Sampling end date and time formatted to ISO8601 standard: YYYY-MM-DDThh:mmZ	unitless
Start_Latitude	Start latitude	decimal degrees North
Start_Longitude	Start longitude	decimal degrees East
End_Latitude	End latitude	decimal degrees North
End_Longitude	End longitude	decimal degrees East
Event_ID	Event number	unitless
Sample_ID	GEOTRACES sample number	unitless
Sample_Depth	Sample depth	meters (m)
Th_234_LPT_CONC_PUMP_byeecv	Particulate Thorium-234 from mesh screens, filtered onto silver filters. Particle size greater than 51 um. Data were decay corrected back to mid-pump times.	mBq/kg
SD1_Th_234_LPT_CONC_PUMP_byeecv	One standard deviation of Th_234_LPT_CONC_PUMP_byeecv	mBq/kg
Flag_Th_234_LPT_CONC_PUMP_byeecv	Quality flag for Th_234_LPT_CONC_PUMP_byeecv	unitless
Th_234_SPT_CONC_PUMP_bm10kg	Particulate Thorium-234 from QMA filters. Particle size of 1 to 51 um. Data were decay corrected back to mid-pump times.	mBq/kg
SD1_Th_234_SPT_CONC_PUMP_bm10kg	One standard deviation of Th_234_SPT_CONC_PUMP_bm10kg	mBq/kg
Flag_Th_234_SPT_CONC_PUMP_bm10kg	Quality flag for Th_234_SPT_CONC_PUMP_bm10kg	unitless

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Instruments

Dataset-specific Instrument Name	McLane Pump
Generic Instrument Name	McLane Pump
Dataset-specific Description	Particulate material was collected using in-situ McLane pumps.
Generic Instrument Description	McLane pumps sample large volumes of seawater at depth. They are attached to a wire and lowered to different depths in the ocean. As the water is pumped through the filter, particles suspended in the ocean are collected on the filters. The pumps are then retrieved and the contents of the filters are analyzed in a lab.

Dataset-specific Instrument Name	Riso Laboratory Anti-coincidence Beta Counters
Generic Instrument Name	Riso Laboratory Anti-coincidence Beta Counters
Dataset-specific Description	234Th samples were analyzed using a Riso Anti-coincidence Beta Counter using a helium/1% butane mixture.
Generic Instrument Description	Low-level beta detectors manufactured by Riso (now Nutech) in Denmark. These instruments accept samples that can be mounted on a 25mm filter holder. These detectors have very low backgrounds, 0.17 counts per minute, and can have counting efficiencies as high as 55%.

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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 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]

US GEOTRACES Pacific Zonal Transect: Rates of supply, removal and internal cycling of trace elements and isotopes (EPZT TEI Rates)

Coverage: East Pacific

Description from NSF award abstract: The goal of GEOTRACES is to identify processes and quantify fluxes that control the distribution of trace elements and isotopes (TEIs) in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions. While the distribution of numerous TEIs will be mapped by a large team of GEOTRACES PIs along this transect, their distribution cannot be properly interpreted without concurrent measurement of tracers capable of providing rates of internal TEI cycling processes and fluxes at boundaries and across interfaces. Naturally-occurring radioisotopes of the Uranium-Thorium series are well suited for studying the sources and sinks of TEIs on time and space scales necessary to interpret lateral and vertical TEI distributions. In this project, a research team from the Woods Hole Oceanographic Institution and the University of South Carolina at Columbia will carry out measurement of a suite of uranium/thorium series radionuclides on the US GEOTRACES cruise to the Eastern Tropical South Pacific (ETSP) Ocean. This radiotracer suite will include shorter-lived 234Th and 228Th as well as the radium quartet (224Ra, 223Ra, 228Ra, 226Ra), which together allow the quantification of rates of horizontal and vertical transport and mixing, as well as removal at ocean boundaries, surface export, and subsurface remineralization.

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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-1232669
NSF Division of Ocean Sciences (NSF OCE)	OCE-1231211

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