Dissolved and total water column 210Po and 210Pb from samples collected on Leg 2 (Hilo, HI to Papeete, French Polynesia) of the US GEOTRACES Pacific Meridional Transect (PMT) cruise (GP15, RR1815) on R/V Roger Revelle from October to November 2018

Website: https://www.bco-dmo.org/dataset/883797
Data Type: Cruise Results
Version: 1
Version Date: 2023-01-31

Project
» US GEOTRACES Pacific Meridional Transect (GP15) (U.S. GEOTRACES PMT)
» Collaborative Research: Lead-210 and Polonium-210 as tracers for scavenging and export: GEOTRACES Pacific Meridional Section (PMT Lead-210 and Polonium-210)

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

Contributors	Affiliation	Role
Cochran, J. Kirk	Stony Brook University - SoMAS (SUNY-SB SoMAS)	Principal Investigator
Stephens, Mark	Florida International University (FIU)	Co-Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This project is part of the international GEOTRACES program, which was created to allow a comprehensive, coordinated study of trace elements and isotopes (TEIs) in the oceans. This project uses the radionuclide pair 210Pb and its grand-daughter, 210Po, to provide important biogeochemical rate information pertinent to the trace elements and isotopes (TEIs) measured during the US GEOTRACES Meridional Transect in the Pacific from Alaska to Tahiti in late 2018. Many processes in the ocean cannot be directly observed and, as such, tracers such as 210Po and 210Pb can be used to provide important constraints on their rates and pathways. 210Po (half-life = 138 d) and 210Pb (half-life = 22.3 y) decay on timescales that are useful to study 1) atmospheric deposition of trace elements, 2) scavenging of particle-reactive trace elements, 3) export of particulate organic carbon (POC) from the photic zone, and 4) the fate of hydrothermal plumes dispersed from the mid-ocean ridge system. The present data set primarily includes measurements of 210Po and 210Pb on filtered water samples (i.e., "dissolved" activities) collected with CTD casts. Surface water samples were collected separately and were unfiltered, so represent "total" activities. Particulate samples also were collected using in situ pumps and those data are reported separately.

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Coverage

Spatial Extent: **N**:18.9066 **E**:-151.9892 **S**:-20 **W**:-155.2579
Temporal Extent: 2018-10-25 - 2018-11-23

Methods & Sampling

Water samples for dissolved 210Pb and 210Po were collected at 12 stations along the 152°W meridional transect and processed on board through the initial plating of Po. For each sample, 10 liters (L) of water were collected using the Scripps Ocean Data Facility (ODF) rosette. Samples were filtered through Acropak filter cartridges (0.8/0.2 micrometers (um)) and acidified to pH ~2 with 40 milliliters (mL) of 6N HCl. They were then shaken well to homogenize. Surface samples were taken by the "fish" and were not filtered upon collection. Thus, the 210Po and 210Pb activities in samples marked "0" depth are total activities. At sea, samples were taken through the initial plating of 210Po. To each sample, iron (10 milligrams Fe, as $FeCl_3$ solution) was added along with 10 milligrams (mg) of Pb and 1.76 disintegrations pre minute (dpm) of 209Po tracer (NIST 4326a). The mixture was shaken and left for 24 hours for tracer/carrier equilibration. Iron hydroxide was precipitated by adding concentrated NH_4OH to raise the pH to 8-9. The $Fe(OH)_3$ precipitate was allowed to settle for 24 hours, after which the sample was filtered through a 1.2 um Versapor filter. The precipitate was dissolved in 20 mL of 6N HCl, and the solution was diluted with DI water to make 80 mL of 1.5 N HCl. Ascorbic acid was added to the 1.5N HCl solution and polonium was plated onto silver planchets (Flynn, 1968; Lee et al., 2014) mounted in Teflon planchet-holders fitted with magnetic stir bars. Plating proceeded on magnetic-stirrer hot plates heated to 80°C for 3 hours. Planchets were then removed from solution, rinsed, and allowed to dry. Dried Po-plated planchets were returned to the shore-based laboratories (Stony Brook University; Florida International University) for alpha counting using Canberra/Mirion passivated implanted planar silicon (PIPS) detectors.

The residual plating solutions were transferred to 125 mL polycarbonate bottles for transport back to Stony Brook University. Due to the long transit back from the Pacific (~3 months), it was decided to eliminate any residual 209Po and 210Po left in the sample after plating by suspending a piece of scrap silver in the sample for 5 days. The silver was then removed, with the time of removal noted. An additional aliquot of 209Po was added to the stored samples, and after ~6 months of storage in the shore-based laboratory (Stony Brook University), Po was plated again using the procedure described above. The 210Po activity obtained at the second plating was then used to back-calculate the activity of 210Pb in the sample at the time of sampling. The calculations outlined by Rigaud et al. (2013) were followed to calculate both the initial 210Po and 210Pb activities.

The scrap silver clean-up step was checked upon sample return to the laboratory by replating several samples without any additional 209Po added. It was found that 5.0 ± 1.6% of the initial Po remained, and correction was made to the calculation of 210Pb activities to account for residual 210Po and 209Po. Additionally, to check the clean-up procedure, two samples were purified by ion exchange after their return to the lab. Agreement was excellent (within 5%).

Recovery of the Pb carrier added to the samples before precipitation was determined after the initial 210Po plating. For this purpose, an aliquot of each stored solution was taken for total Pb yield by Atomic Absorption Spectroscopy or Inductively-Coupled-Plasma Mass Spectroscopy.

Data Processing Description

Data Processing:
Calculation of radioactivites (disintegrations pre minute - dpm - or Becquerels - Bq) from count rates measured in the alpha spectrometers were made using the procedure outlined in Rigaud et al. (2013).

Quality flags were applied following the GEOTRACES flag definitions (https://www.geotraces.org/geotraces-quality-flag-policy/) where 1 = "good data".

BCO-DMO Processing:
- renamed fields to comply with BCO-DMO naming conventions;
- created ISO 8601 date-time field and removed original (separate) date and time columns;
- removed end date, end time, end lat, and end lon (all empty);
- moved rows for station 18.3 from Leg 2 file to Leg 1;
- replaced "11..00" with "11.00" in Start_Latitude column.

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Data Files

File	
leg2.csv	(Octet Stream, 10.76 KB) MD5:d3663c9dec7a8940d7143f5a0a9f58d2
Primary data file for dataset ID 883797, version 1.	

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Related Publications

Flynn, W. W. (1968). The determination of low levels of polonium-210 in environmental materials. Analytica Chimica Acta, 43, 221–227. doi:10.1016/s0003-2670(00)89210-7 https://doi.org/10.1016/S0003-2670(00)89210-7
Methods

Lee, H. M., Hong, G. H., Baskaran, M., Kim, S. H., & Kim, Y. I. (2014). Evaluation of plating conditions for the recovery of 210Po on a Ag planchet. Applied Radiation and Isotopes, 90, 170–176. https://doi.org/10.1016/j.apradiso.2014.03.025
Methods

Rigaud, S., Puigcorbé, V., Cámara-Mor, P., Casacuberta, N., Roca-Martí, M., Garcia-Orellana, J., … Church, T. (2013). A methods assessment and recommendations for improving calculations and reducing uncertainties in the determination of210Po and210Pb activities in seawater. Limnology and Oceanography: Methods, 11(10), 561–571. doi:10.4319/lom.2013.11.561
Methods

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Related Datasets

Continues

Cochran, J. K., Stephens, M. (2023) **Dissolved and total water column 210Po and 210Pb from samples collected on Leg 1 (Seattle, WA to Hilo, HI) of the US GEOTRACES Pacific Meridional Transect (PMT) cruise (GP15, RR1814) on R/V Roger Revelle from September to October 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-01-06 doi:10.26008/1912/bco-dmo.883724.1 [view at BCO-DMO]
Relationship Description: GP15 was made up of two cruise legs, RR1814 (Leg 1) and RR1815 (Leg 2).

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Parameters

Parameter	Description	Units
Station_ID	Station number	unitless
Start_ISO_DateTime_UTC	Date and time (UTC) at start of sample collection in ISO8601 format	unitless
Start_Latitude	Latitude at start of sample collection	degrees North
Start_Longitude	Longitude at start of sample collection	degrees East
Event_ID	Event number	unitless
Sample_ID	GEOTRACES sample number	unitless
Sample_Depth	Sample depth	meters (m)
Pb_210_T_CONC_BOTTLE_rfjabp	210Pb of unfiltered surface water sample	milliBecquerels per kilogram of water (mBq/kg)

SD1_Pb_210_T_CONC_BOTTLE_rfjabp	Uncertainty as 1 sigma standard deviation for Pb_210_T_CONC_BOTTLE_rfjabp	milliBecquerels per kilogram of water (mBq/kg)
Flag_Pb_210_T_CONC_BOTTLE_rfjabp	Quality flag for Pb_210_T_CONC_BOTTLE_rfjabp (1 = "good data")	unitless
Po_210_T_CONC_BOTTLE_vapogm	210Po on unfiltered surface water sample	milliBecquerels per kilogram of water (mBq/kg)
SD1_Po_210_T_CONC_BOTTLE_vapogm	Uncertainty as 1 sigma standard deviation for Po_210_T_CONC_BOTTLE_vapogm	milliBecquerels per kilogram of water (mBq/kg)
Flag_Po_210_T_CONC_BOTTLE_vapogm	Quality flag for Po_210_T_CONC_BOTTLE_vapogm (1 = "good data")	unitless
Pb_210_D_CONC_BOTTLE_kaxx2u	210Pb activity of filtered water sample	milliBecquerels per kilogram of water (mBq/kg)
SD1_Pb_210_D_CONC_BOTTLE_kaxx2u	Uncertainty as 1 sigma standard deviation for Pb_210_D_CONC_BOTTLE_kaxx2u	milliBecquerels per kilogram of water (mBq/kg)
Flag_Pb_210_D_CONC_BOTTLE_kaxx2u	Quality flag for Pb_210_D_CONC_BOTTLE_kaxx2u (1 = "good data")	unitless
Po_210_D_CONC_BOTTLE_g7hxey	210Po activity of filtered water sample	milliBecquerels per kilogram of water (mBq/kg)
SD1_Po_210_D_CONC_BOTTLE_g7hxey	Uncertainty as 1 sigma standard deviation for Po_210_D_CONC_BOTTLE_g7hxey	milliBecquerels per kilogram of water (mBq/kg)
Flag_Po_210_D_CONC_BOTTLE_g7hxey	Quality flag for Po_210_D_CONC_BOTTLE_g7hxey (1 = "good data")	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Niskin bottle
Dataset-specific Description	For each sample, 10 liters (L) of water were collected using the Scripps Ocean Data Facility (ODF) rosette.
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	
Generic Instrument Name	Spectrometer
Dataset-specific Description	210Po and 210Pb activities were measured on Canberra passivated implanted planar silicon (PIPS) detectors coupled to a Mirion Alpha Analyst™ alpha spectrometer (Stony Brook University) or Ortec Alpha System (Florida International University).
Generic Instrument Description	A spectrometer is an optical instrument used to measure properties of light over a specific portion of the electromagnetic spectrum.

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Deployments

RR1815

Website	https://www.bco-dmo.org/deployment/776917
Platform	R/V Roger Revelle
Report	https://datadocs.bco-dmo.org/docs/geotraces/GEOTRACES_PMT/casciotti/data_docs/GP15_Cruise_Report_with_ODF_Report.pdf
Start Date	2018-10-24
End Date	2018-11-24
Description	Additional cruise information is available from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/RR1815

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Project Information

US GEOTRACES Pacific Meridional Transect (GP15) (U.S. GEOTRACES PMT)

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

Coverage: Pacific Meridional Transect along 152W (GP15)

A 60-day research cruise took place in 2018 along a transect form Alaska to Tahiti at 152° W. A description of the project titled "*Collaborative Research: Management and implementation of the US GEOTRACES Pacific Meridional Transect*", funded by NSF, is below. Further project information is available on the US GEOTRACES website and on the cruise blog. A detailed cruise report is also available as a PDF.

Description from NSF award abstract:
GEOTRACES is a global effort in the field of Chemical Oceanography in which the United States plays a major role. The goal of the GEOTRACES program is to understand the distributions of many elements and their isotopes in the ocean. Until quite recently, these elements could not be measured at a global scale. Understanding the distributions of these elements and isotopes will increase the understanding of processes that shape their distributions and also the processes that depend on these elements. For example, many "trace elements" (elements that are present in very low amounts) are also important for life, and their presence or absence can play a vital role in the population of marine ecosystems. This project will launch the next major U.S. GEOTRACES expedition in the Pacific Ocean between Alaska and Tahiti. The award made here would support all of the major infrastructure for this expedition, including the research vessel, the sampling equipment, and some of the core oceanographic measurements. This project will also support the personnel needed to lead the expedition and collect the samples.

This project would support the essential sampling operations and infrastructure for the U.S. GEOTRACES Pacific Meridional Transect along 152° W to support a large variety of individual science projects on trace element and isotope (TEI) biogeochemistry that will follow. Thus, the major objectives of this management proposal are: (1) plan and coordinate a 60 day research cruise in 2018; (2) obtain representative samples for a wide variety of TEIs using a conventional CTD/rosette, GEOTRACES Trace Element Sampling Systems, and in situ pumps; (3) acquire conventional CTD hydrographic data along with discrete samples for salinity, dissolved oxygen, algal pigments, 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 data to the GEOTRACES Data Assembly Centre (via the US BCO-DMO data center); and (6) coordinate all cruise communications between investigators, including preparation of a hydrographic report/publication. This project would also provide baseline measurements of TEIs in the Clarion-Clipperton fracture zone (~7.5°N-17°N, ~155°W-115°W) where large-scale deep sea mining is planned. Environmental impact assessments are underway in partnership with the mining industry, but the effect of mining activities on TEIs in the water column is one that could be uniquely assessed by the GEOTRACES community. In support of efforts to communicate the science to a wide audience the investigators will recruit an early career freelance science journalist with interests in marine science and oceanography to participate on the cruise and do public outreach, photography and/or videography, and social media from the ship, as well as to submit articles about the research to national media. The project would also support several graduate students.

Collaborative Research: Lead-210 and Polonium-210 as tracers for scavenging and export: GEOTRACES Pacific Meridional Section (PMT Lead-210 and Polonium-210)

NSF Award Abstract:
The goal of the international GEOTRACES program is to understand the distributions of trace chemical elements and their isotopes in the oceans. These chemical species play important roles in the ocean as nutrients, tracers of current and past oceanographic processes, and as contaminants from human activity. Their biogeochemical cycling has direct implications for research in such diverse areas as the carbon cycle, climate change, and ocean ecosystems. This project will use measurement of two natural radionuclides -- lead-210 and polonium-210 -- to provide important information about the rates of processes that affect trace elements and isotopes (TEIs) that will be measured during a U.S. GEOTRACES expedition in the Pacific Ocean in 2018. The research proposed here will address key tasks formulated within the GEOTRACES Science Plan.

Many processes in the ocean cannot be observed directly but tracers such as polonium-210 (half-life = 138 days) and lead-210 (half-life = 22.3 years) that have unique chemical properties and relevant decay timescales can be used to provide important constraints on their rates and pathways. The goals of this research are to: 1) use Pb-210, along with another project measuring Be-7, in aerosols and precipitation to characterize aerosol and TEI sources, 2) determine scavenging rates of particle-reactive TEIs through the water column using Po-210 and Pb-210, 3) use Po-210 / Pb-210 disequilibrium in the upper water column as a proxy for the sinking flux of particulate organic carbon (POC), and 4) use Pb-210as a tracer of the influence of hydrothermal processes on water column distributions of TEIs. This work will build on a database of Po/Pb distributions in the world ocean (and the Pacific Ocean, in particular) obtained through programs such as GEOSECS, GEOTRACES, and independent studies. A graduate student will be trained as part of this project. The lead investigator, Cochran, plans to incorporate information about GEOTRACES sampling strategies in the planning for a travelling exhibition on "The Oceans" through his adjunct appointment at the American Museum of Natural History (New York). Project partner Kadko plans to incorporate GEOTRACES work in an international graduate course through the Nippon Foundation, Partnership for Observation of the Global Oceans Center of Excellence.

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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-1736591
NSF Division of Ocean Sciences (NSF OCE)	OCE-1736612

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