

# Dissolved and total water column <sup>210</sup>Po and <sup>210</sup>Pb 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

**Website:** <https://www.bco-dmo.org/dataset/883724>

**Data Type:** Cruise Results

**Version:** 1

**Version Date:** 2023-01-06

## 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
<a href="#">Cochran, J. Kirk</a>	Stony Brook University - SoMAS (SUNY-SB SoMAS)	Principal Investigator
<a href="#">Rauch, Shannon</a>	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 <sup>210</sup>Pb and its grand-daughter, <sup>210</sup>Po, 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 <sup>210</sup>Po and <sup>210</sup>Pb can be used to provide important constraints on their rates and pathways. <sup>210</sup>Po (half-life = 138 d) and <sup>210</sup>Pb (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 <sup>210</sup>Po and <sup>210</sup>Pb 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.

## Table of Contents

- [Coverage](#)
- [Dataset Description](#)
  - [Methods & Sampling](#)
  - [Data Processing Description](#)
- [Data Files](#)
- [Related Publications](#)
- [Related Datasets](#)
- [Parameters](#)
- [Instruments](#)
- [Deployments](#)
- [Project Information](#)
- [Program Information](#)
- [Funding](#)

## Coverage

**Spatial Extent:** N:56.058 E:-151.9998 S:19.68 W:-156.962

**Temporal Extent:** 2018-09-26 - 2018-10-21

## Methods & Sampling

Water samples for dissolved <sup>210</sup>Pb and <sup>210</sup>Po 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 ( $\mu\text{m}$ )) and acidified to pH  $\sim 2$  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  $^{210}\text{Po}$  and  $^{210}\text{Pb}$  activities in samples marked "0" depth are total activities. At sea, samples were taken through the initial plating of  $^{210}\text{Po}$ . To each sample, iron (10 milligrams Fe, as  $\text{FeCl}_3$  solution) was added along with 10 milligrams (mg) of Pb and 1.76 disintegrations per minute (dpm) of  $^{209}\text{Po}$  tracer (NIST 4326a). The mixture was shaken and left for 24 hours for tracer/carrier equilibration. Iron hydroxide was precipitated by adding concentrated  $\text{NH}_4\text{OH}$  to raise the pH to 8-9. The  $\text{Fe}(\text{OH})_3$  precipitate was allowed to settle for 24 hours, after which the sample was filtered through a 1.2  $\mu\text{m}$  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  $80^\circ\text{C}$  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 ( $\sim 3$  months), it was decided to eliminate any residual  $^{209}\text{Po}$  and  $^{210}\text{Po}$  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  $^{209}\text{Po}$  was added to the stored samples, and after  $\sim 6$  months of storage in the shore-based laboratory (Stony Brook University), Po was plated again using the procedure described above. The  $^{210}\text{Po}$  activity obtained at the second plating was then used to back-calculate the activity of  $^{210}\text{Pb}$  in the sample at the time of sampling. The calculations outlined by Rigaud et al. (2013) were followed to calculate both the initial  $^{210}\text{Po}$  and  $^{210}\text{Pb}$  activities.

The scrap silver clean-up step was checked upon sample return to the laboratory by replating several samples without any additional  $^{209}\text{Po}$  added. It was found that  $5.0 \pm 1.6\%$  of the initial Po remained, and correction was made to the calculation of  $^{210}\text{Pb}$  activities to account for residual  $^{210}\text{Po}$  and  $^{209}\text{Po}$ . 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  $^{210}\text{Po}$  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 radioactivities (disintegrations per 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.

[ [table of contents](#) | [back to top](#) ]

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## Data Files

File
<b>leg1.csv</b> (Octet Stream, 7.94 KB) MD5:03769351b154e1e201f3ca9a1c3a8b0d
Primary data file for dataset ID 883724, version 1.

[ [table of contents](#) | [back to top](#) ]

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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](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 <sup>210</sup>Po 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 of <sup>210</sup>Po and <sup>210</sup>Pb activities in seawater. *Limnology and Oceanography: Methods*, 11(10), 561–571.  
doi:[10.4319/lom.2013.11.561](https://doi.org/10.4319/lom.2013.11.561)  
*Methods*

[ [table of contents](#) | [back to top](#) ]

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## Related Datasets

### IsContinuedBy

Cochran, J. K. (2023) **Dissolved and total water column <sup>210</sup>Po and <sup>210</sup>Pb 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.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-01-31 doi:10.26008/1912/bco-dmo.883797.1 [[view at BCO-DMO](#)]  
*Relationship Description: GP15 was made up of two cruise legs, RR1814 (Leg 1) and RR1815 (Leg 2).*

[ [table of contents](#) | [back to top](#) ]

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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_r7wcpj	210Pb of unfiltered surface water sample	milliBecquerels per kilogram of water (mBq/kg)
SD1_Pb_210_T_CONC_BOTTLE_r7wcpj	Uncertainty as 1 sigma standard deviation for Pb_210_T_CONC_BOTTLE_r7wcpj	milliBecquerels per kilogram of water (mBq/kg)
Flag_Pb_210_T_CONC_BOTTLE_r7wcpj	Quality flag for Pb_210_T_CONC_BOTTLE_r7wcpj (1 = "good data")	unitless
Po_210_T_CONC_BOTTLE_owadoh	210Po on unfiltered surface water sample	milliBecquerels per kilogram of water (mBq/kg)
SD1_Po_210_T_CONC_BOTTLE_owadoh	Uncertainty as 1 sigma standard deviation for Po_210_T_CONC_BOTTLE_owadoh	milliBecquerels per kilogram of water (mBq/kg)
Flag_Po_210_T_CONC_BOTTLE_owadoh	Quality flag for Po_210_T_CONC_BOTTLE_owadoh (1 = "good data")	unitless
Pb_210_D_CONC_BOTTLE_duoqhf	210Pb activity of filtered water sample	milliBecquerels per kilogram of water (mBq/kg)
SD1_Pb_210_D_CONC_BOTTLE_duoqhf	Uncertainty as 1 sigma standard deviation for Pb_210_D_CONC_BOTTLE_duoqhf	milliBecquerels per kilogram of water (mBq/kg)
Flag_Pb_210_D_CONC_BOTTLE_duoqhf	Quality flag for Pb_210_D_CONC_BOTTLE_duoqhf (1 = "good data")	unitless
Po_210_D_CONC_BOTTLE_to05ef	210Po activity of filtered water sample	milliBecquerels per kilogram of water (mBq/kg)
SD1_Po_210_D_CONC_BOTTLE_to05ef	Uncertainty as 1 sigma standard deviation for Po_210_D_CONC_BOTTLE_to05ef	milliBecquerels per kilogram of water (mBq/kg)
Flag_Po_210_D_CONC_BOTTLE_to05ef	Quality flag for Po_210_D_CONC_BOTTLE_to05ef (1 = "good data")	unitless

[ [table of contents](#) | [back to top](#) ]

## Instruments

<b>Dataset-specific Instrument Name</b>	
<b>Generic Instrument Name</b>	Niskin bottle
<b>Dataset-specific Description</b>	For each sample, 10 liters (L) of water were collected using the Scripps Ocean Data Facility (ODF) rosette.
<b>Generic Instrument Description</b>	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.

<b>Dataset-specific Instrument Name</b>	
<b>Generic Instrument Name</b>	Spectrometer
<b>Dataset-specific Description</b>	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).
<b>Generic Instrument Description</b>	A spectrometer is an optical instrument used to measure properties of light over a specific portion of the electromagnetic spectrum.

[ [table of contents](#) | [back to top](#) ]

## Deployments

### RR1814

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/776913">https://www.bco-dmo.org/deployment/776913</a>
<b>Platform</b>	R/V Roger Revelle
<b>Report</b>	<a href="https://datadocs.bco-dmo.org/docs/geotraces/GEOTRACES_PMT/casciotti/data_docs/GP15_Cruise_Report_with_ODF_Report.pdf">https://datadocs.bco-dmo.org/docs/geotraces/GEOTRACES_PMT/casciotti/data_docs/GP15_Cruise_Report_with_ODF_Report.pdf</a>
<b>Start Date</b>	2018-09-18
<b>End Date</b>	2018-10-21
<b>Description</b>	Additional cruise information is available from the Rolling Deck to Repository (R2R): <a href="https://www.rvdata.us/search/cruise/RR1814">https://www.rvdata.us/search/cruise/RR1814</a>

[ [table of contents](#) | [back to top](#) ]

## 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 from 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-210 as 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.

## 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.

## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1736591</a>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1736612</a>