Water column dissolved radium-226 and radium-228 from 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/825947
Data Type: Cruise Results
Version: 3
Version Date: 2023-10-02

Project
» US GEOTRACES Pacific Meridional Transect (GP15) (U.S. GEOTRACES PMT)
» Collaborative Research: US GEOTRACES PMT: Sources and Rates of Trace Element and Isotope Cycling Derived from the Radium Quartet (PMT Radium Isotopes)

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

Contributors	Affiliation	Role
Charette, Matthew A.	Woods Hole Oceanographic Institution (WHOI)	Principal Investigator, Contact
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Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Water column dissolved radium-226 and radium-228 from 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. In this dataset version (v3), the radium-226 data have been updated from the previous version of the dataset.

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Coverage

Spatial Extent: **N**:18.907 **E**:-151.986 **S**:-20 **W**:-155.258
Temporal Extent: 2018-10-25 - 2018-11-23

Methods & Sampling

At sea, Radium-226 samples were collected following the GEOTRACES cookbook. Samples were collected from a 30-liter (L) Niskin mounted directly above a McLane large volume in situ pump WTS-LV (>1000 meters) or on a CTD Rosette (<1000 meters). These samples (10-25 L) were gravity-filtered through 15 grams (g) of manganese oxide impregnated acrylic fiber at approximately 0.5 liters per minute (L/min). The filtrate was collected inside of a graduated rigid sided container and the volume was recorded. A mass was also obtained by using a hand-held digital balance.

The Mn fibers from the Niskin bottles were rinsed with deionized water back at Woods Hole Oceanographic Institution (WHOI), partially dried, and sealed within a fiber holder after being flushed with helium equivalent to 30 column

volumes. Samples were stored for a minimum of 12 days and analyzed for 226Ra via 222Rn ingrowth using alpha scintillation counting (Key et al., 1979). Samples were counted for 1-20 hours depending on the activity on the fiber, which resulted in counting uncertainties of ~2% dependent upon 226Ra content on the fiber and sample volume.

Radium-228 was collected on manganese-coated cartridges filtered at depth using an adapted McLane in situ pump (WTS-LV). The pumps were programmed to filter 1500-2000L of seawater per deployment. The cartridges were rinsed with radium-free fresh water and excess moisture was removed using compressed air. Samples were analyzed multiple times using a delayed coincidence counter (RaDeCC) for determination of radium-228 via thorium-228 ingrowth. At selected stations, samples were ashed in a muffle furnace at 820 degrees Celsius for 24 hours and the fiber ash was transferred to polystyrene vials, sealed with epoxy (to prevent 222Rn loss), and counted on high purity, well-type germanium detectors to measure 228Ra, using the lines of 228Ac (338 keV, 911 keV, and 969 keV).

In addition to the water column samples, large volume surface samples were collected by pumping from a depth of 2 meters through a single Mn-cartridge accompanied by a 15-25-liter sample that was passed through a 15 g Mn-fiber column to retain radium-226.

Data Processing Description

Data Processing:
The data were corrected for decay from the time of sampling. Data is originally calculated in disintegrations per minute per liter (dpm/L) and is converted to milli-Becquerels per kilogram (mBq/kg) using the standard ocean rho = 1.0235 kg/L and 1 dpm = 16.667 mBq.

Quality Flags:
Data were flagged using the SeaDataNet quality flag scheme. Two additional flags, 'B' and 'C' (defined below), were also assigned to this dataset. For more information on SeaDataNet flags, see: https://www.geotraces.org/geotraces-quality-flag-policy/ and https://www.seadatanet.org/Standards/Data-Quality-Control.

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;
B = Value obtained from Radium/Barium ratio;
C = Value measured through gamma spectroscopy.

BCO-DMO Processing Description

Version 1:
version 1 date: 2020-10-01
- renamed fields to comply with BCO-DMO naming conventions;
- added date/time columns in ISO 8601 format;
- replaced "N/A" with "nd" to indicate "no data".

Version 2:
version 2 date: 2021-12-28 (v2)
- - same as version 1, plus made the following corrections to the Event_ID column:
- changed event number for Sample 14731 from 6882 to 6879;
- changed event number for Samples 14883-14890 from 6828 to 6898;
- changed event number for Sample 33 from 6943 to 6942.

Version 3:
version 3 date: 2022-09-29
- imported two Excel files, "BCODMO GP15 Charette 226Radium leg2.xlsx" and "BCODMO GP15 Charette 228Radium leg2.xlsx", into the BCO-DMO system;
- joined the two files, using Event_ID and Sample_ID as they key, to create a single dataset;
- renamed the 'Flag' field for Ra228 to follow GEOTRACES naming conventions;

- renamed the Ra-228 fields using the parameter names assigned by the GEOTRACES DOoR portal;
- saved the final file as "825947_v3_gp15_ra226_ra228_leg2.csv"
- note that in the final csv file, missing data are blank/empty.

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Data Files

File
825947_v3_gp15_ra226_ra228_leg2.csv (Comma Separated Values (.csv), 29.72 KB) MD5:b20ff80eaa1cf8d7fe68b016218ee0a5 Primary data file for dataset ID 825947, version 3.

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Related Publications

Charette, M. A., Dulaiova, H., Gonneea, M. E., Henderson, P. B., Moore, W. S., Scholten, J. C., & Pham, M. K. (2012). GEOTRACES radium isotopes interlaboratory comparison experiment. Limnology and Oceanography: Methods, 10(6), 451–463. doi:10.4319/lom.2012.10.451
General

Cutter, G.A., Andersson, P., Codispoti, L., Croot, P., Francois, R., Lohan, M., Obata, H., van der Loeff, M. R. (2014) Sampling and Sample-Handing Protocols for GEOTRACES Cruises (cookbook) Version 2.0; December 2014. http://www.geotraces.org/images/stories/documents/intercalibration/Cookbook_v2.pdf
Methods

Key, R. M., Brewer, R. L., Stockwell, J. H., Guinasso, N. L., & Schink, D. R. (1979). Some improved techniques for measuring radon and radium in marine sediments and in seawater. Marine Chemistry, 7(3), 251–264. doi:10.1016/0304-4203(79)90042-2
Methods

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Related Datasets

Continues

Charette, M. A., Moore, W. S. (2023) **Water column dissolved radium-226 and radium-228 from 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 3) Version Date 2023-10-02 doi:10.26008/1912/bco-dmo.825891.3 [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	GEOTRACES station number	unitless
Start_Date_UTC	Sample collection start date	unitless
Start_Time_UTC	Sample collection start time (UTC)	unitless
Start_ISO_DateTime_UTC	Sampling start date and time (UTC) in ISO 8601 format	unitless
End_Date_UTC	Sample collection end date	unitless
End_Time_UTC	Sample collection end time (UTC)	unitless
End_ISO_DateTime_UTC	Sampling end date and time (UTC) in ISO 8601 format	unitless
Start_Latitude	Sample collection start Latitude; negative values = South	decimal degrees
Start_Longitude	Sample collection start Longitude; negative values = West	decimal degrees
End_Latitude	Sample collection end Latitude; negative values = South	decimal degrees
End_Longitude	Sample collection end Longitude; negative values = West	decimal degrees
Event_ID	GEOTRACES event number	unitless
Sample_ID	GEOTRACES sample number	unitless
Sample_Depth	Depth of sample collection	meters (m)
Ra_226_D_CONC_BOTTLE_zkto8n	Dissolved Radium-226 activity	milliBecquerels per kilogram (mBq/kg)
SD1_Ra_226_D_CONC_BOTTLE_zkto8n	One standard deviation of Ra_226_D_CONC_BOTTLE_zkto8n	milliBecquerels per kilogram (mBq/kg)
Flag_Ra_226_D_CONC_BOTTLE_zkto8n	Quality flag for Ra_226_D_CONC_BOTTLE_zkto8n; refer to 'Data Processing' section of metadata for flag definitions	unitless
Ra_228_D_CONC_PUMP_eokmy1	Dissolved Radium-228 activity	milliBecquerels per kilogram (mBq/kg)
SD1_Ra_228_D_CONC_PUMP_eokmy1	One standard deviation of Ra_228_D_CONC_PUMP_eokmy1	milliBecquerels per kilogram (mBq/kg)
Flag_Ra_228_D_CONC_PUMP_eokmy1	Quality flag for Ra_228_D_CONC_PUMP_eokmy1; refer to 'Data Processing' section of metadata for flag definitions	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	McLane Large Volume Pumping System WTS-LV
Dataset-specific Description	Radium-228 was collected on manganese-coated cartridges filtered at depth using an adapted McLane in situ pump (WTS-LV).
Generic Instrument Description	The WTS-LV is a Water Transfer System (WTS) Large Volume (LV) pumping instrument designed and manufactured by McLane Research Labs (Falmouth, MA, USA). It is a large-volume, single-event sampler that collects suspended and dissolved particulate samples in situ. Ambient water is drawn through a modular filter holder onto a 142-millimeter (mm) membrane without passing through the pump. The standard two-tier filter holder provides prefiltering and size fractioning. Collection targets include chlorophyll maximum, particulate trace metals, and phytoplankton. It features different flow rates and filter porosity to support a range of specimen collection. Sampling can be programmed to start at a scheduled time or begin with a countdown delay. It also features a dynamic pump speed algorithm that adjusts flow to protect the sample as material accumulates on the filter. Several pump options range from 0.5 to 30 liters per minute, with a max volume of 2,500 to 36,000 liters depending on the pump and battery pack used. The standard model is depth rated to 5,500 meters, with a deeper 7,000-meter option available. The operating temperature is -4 to 35 degrees Celsius. The WTS-LV is available in four different configurations: Standard, Upright, Bore Hole, and Dual Filter Sampler. The high-capacity upright WTS-LV model provides three times the battery life of the standard model. The Bore-Hole WTS-LV is designed to fit through a narrow opening such as a 30-centimeter borehole. The dual filter WTS-LV features two vertical intake 142 mm filter holders to allow simultaneous filtering using two different porosities.

Dataset-specific Instrument Name	30L Niskin
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Radium-226 samples were collected from a 30L Niskin mounted directly above McLane large volume in situ pump WTS-LV (>1000 m) or on a CTD 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	Radium Delayed Coincidence (RaDeCC) counter
Generic Instrument Name	Radium Delayed Coincidence Counter
Dataset-specific Description	Samples were analyzed using Radium Delayed Coincidence (RaDeCC) counters and high-purity, well-type germanium detectors.
Generic Instrument Description	The RaDeCC is an alpha scintillation counter that distinguishes decay events of short-lived radium daughter products based on their contrasting half-lives. This system was pioneered by Giffin et al. (1963) and adapted for radium measurements by Moore and Arnold (1996). References: Giffin, C., A. Kaufman, W.S. Broecker (1963). Delayed coincidence counter for the assay of actinon and thoron. J. Geophys. Res., 68, pp. 1749-1757. Moore, W.S., R. Arnold (1996). Measurement of 223Ra and 224Ra in coastal waters using a delayed coincidence counter. J. Geophys. Res., 101 (1996), pp. 1321-1329. Charette, Matthew A.; Dulaiova, Henrieta; Gonneea, Meagan E.; Henderson, Paul B.; Moore, Willard S.; Scholten, Jan C.; Pham, M. K. (2012). GEOTRACES radium isotopes interlaboratory comparison experiment. Limnology and Oceanography - Methods, vol 10, pg 451.

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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: US GEOTRACES PMT: Sources and Rates of Trace Element and Isotope Cycling Derived from the Radium Quartet (PMT Radium Isotopes)

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. Naturally occurring radioactive isotopes of the element radium can be used to measure the rates of important processes in the ocean. In turn, making these rate measurements at the same time as other trace element and isotope data are collected enables a more complete interpretation of these data. The investigators propose to measure the four isotopes of radium -- Ra-223, Ra-224, Ra-226, and Ra-228 -- on a U.S. GEOTRACES expedition from Alaska to Tahiti in 2018. The radium isotope data will be particularly useful in investigating trace element input and removal processes associated with ocean boundaries (rivers, continental shelves, and the ocean bottom) and with mid-ocean ridge hydrothermal vents and the long-range dispersal of their neutrally buoyant plumes. The investigators will also investigate the processes controlling the internal cycling of the longest-lived isotope, Ra-226, compared to the element barium, which has a very similar chemistry to radium.

The proposed work would address a number of key questions regarding trace element inputs from ocean boundaries and their potential impact on ocean productivity and biogeochemistry. As iron is an important nutrient for marine phytoplankton, the investigators will quantify the rates of lateral trace element transport from the Gulf of Alaska margin out to and including the offshore High Nutrient Low Chlorophyll region of the subarctic Northeast Pacific Ocean. In the ocean subsurface, they will seek to understand the trace element fluxes associated with high temperature hydrothermal venting, and the rate at which trace elements and isotopes are removed via scavenging along the hydrothermal plume. Lastly, the work will lead to an improved understanding of a marine carbonate sediment dating technique via an investigation of Ra-226 and barium fractionation processes in the upper ocean. The project will involve collaboration between two U.S. institutions and a partner in France who will analyze some of the samples. Two graduate students will participate in the project. Moore will supervise an undergraduate student through the South Carolina Alliance for Minority Participation, and will encourage this student to develop a senior thesis based on their participation in 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-1736277

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