

# Dissolved barium (Ba) concentrations in seawater samples collected on the US GEOTRACES GP17-OCE cruise on R/V Roger Revelle (RR2214) in the South Pacific and Southern Oceans from December 2022 to January 2023

**Website:** <https://www.bco-dmo.org/dataset/947790>

**Data Type:** Cruise Results

**Version:** 1

**Version Date:** 2025-01-02

## Project

- » [US GEOTRACES GP17-OCE: Investigating the role of the Southern Ocean's biogeochemical divide in shaping the global distributions of radium and barium isotopes](#) (GP17-OCE Ra and Ba isotopes)
- » [US GEOTRACES GP17 Section: South Pacific and Southern Ocean \(GP17-OCE\)](#) (GP17-OCE)

## Program

- » [U.S. GEOTRACES](#) (U.S. GEOTRACES)

Contributors	Affiliation	Role
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## Abstract

This dataset includes measurements of dissolved barium (Ba) concentrations in the South Pacific and Southern Ocean from the US GEOTRACES GP17 section (GP17-OCE, Papeete, Tahiti to Punta Arenas, Chile) on R/V Roger Revelle from December 2022 to January 2023.

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## Coverage

**Spatial Extent:** N:-19.894775 E:-75.097173 S:-67.009839 W:-152.000291  
**Temporal Extent:** 2022-12-03 - 2023-01-24

## Methods & Sampling

Clean seawater samples were collected using a GEOTRACES CTD referred to as GT-C/12-liter GoFlo, and also from the Super-GeoFISH towed surface vehicle and from the ship's underway system for 1 sample where bad weather did not allow for the GeoFISH deployment. For more information, see the cruise report. Water samples were filtered through pre-cleaned, 0.2-micrometer ( $\mu\text{m}$ ) Pall Acropak Supor filter capsules as described elsewhere (e.g., Cutter et al., 2014). Filtered water was collected in 125-milliliter (mL) HDPE bottles (Nalgene) that had been pre-cleaned following the GEOTRACES protocol for trace-metal clean sampling.

Seawater samples were analyzed using a standard methodology for determining dissolved barium (Ba) concentrations in seawater samples. This process involves the use of barium-135 ( $^{135}\text{Ba}$ ) isotope dilution coupled with analysis via inductively coupled plasma mass spectrometry (ICP-MS) using a ThermoScientific iCAP Q operated in Kinetic Energy Dispersion (KED) mode. Solutions containing 100 microliters ( $\mu\text{L}$ ) of seawater sample, 100  $\mu\text{L}$  of a tellurium (Te) solution, which serves as a monitor for instrumental mass bias, and 100  $\mu\text{L}$  of a  $^{135}\text{Ba}$  spike solution were analyzed, eluted to 2 mL with 2%  $\text{HNO}_3$ . The enriched  $^{135}\text{Ba}$  isotope spike is  $\text{BaCO}_3$  obtained from Oak Ridge National Laboratories (batch no.142890) The ratios of barium isotopes, specifically the ratio of  $^{135}\text{Ba}/^{137}\text{Ba}$ , are measured in the samples. The spike-to-sample ratio is then calculated using standard isotope dilution equations, and the resultant [Ba] in the sample (in nanomoles) was determined based on the quantity of spike added. Optimal spiking is achieved when spiked samples exhibit  $^{135}\text{Ba}/^{137}\text{Ba}$  between 1.6 and 32.7 (Stracke et al., 2014), noting that our samples exhibited  $^{135}\text{Ba}/^{137}\text{Ba}$  between 5.65 and 23.40. [Ba] was converted to nanomoles per kilogram (nmol/kg) based on the ocean's average density at the surface, 1.027 grams per cubic centimeter ( $\text{g}/\text{cm}^3$ ).

## Data Processing Description

### Quality Flags:

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>.

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.

## BCO-DMO Processing Description

- Imported original file "IDP\_BaOCE.csv" into the BCO-DMO system.
- Renamed fields to comply with BCO-DMO naming conventions.
- Converted all dates to format YYYY-MM-DD.
- Saved final file as "947790\_v1\_gp17-oce\_dissolved\_ba.csv".

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## Data Files

**File**

**947790\_v1\_gp17-oce\_dissolved\_ba.csv**(Comma Separated Values (.csv), 122.51 KB)  
MD5:015109a7c31242c3b313a0f40455c168

Primary data file for dataset ID 947790, version 1

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## Related Publications

Cutter, G.A., Andersson, P., Codispoti, L., Croot, P., Francois, R., Lohan, M., Obata, H., van der Loeff, M. R. (2014) Sampling and Sample-Handling Protocols for GEOTRACES Cruises (cookbook) Version 2.0; December 2014. [http://www.geotraces.org/images/stories/documents/intercalibration/Cookbook\\_v2.pdf](http://www.geotraces.org/images/stories/documents/intercalibration/Cookbook_v2.pdf)  
*Methods*

Stracke, A., Scherer, E. E., & Reynolds, B. C. (2014). Application of Isotope Dilution in Geochemistry. Treatise on Geochemistry, 71-86. <https://doi.org/10.1016/b978-0-08-095975-7.01404-2>  
*Methods*

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## Parameters

Parameter	Description	Units
Cruise_ID	GEOTRACES cruise name	unitless
Station_ID	GEOTRACES station number	unitless
Event_ID	GEOTRACES event number	unitless
GEOTRC_INSTR	Sampling method	unitless
Start_ISO_DateTime_UTC	Date and time (UTC) at start of sample collection in ISO 8601 format	unitless
Start_Date_UTC	Date (UTC) at start of sample collection	unitless
Start_Time_UTC	Time (UTC) at start of sample collection	unitless
End_ISO_DateTime_UTC	Date and time (UTC) at end of sample collection in ISO 8601 format	unitless
End_Date_UTC	Date (UTC) at end of sample collection	unitless
End_Time_UTC	Time (UTC) at end of sample collection	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
Rosette_Position	Trace metal clean rosette position. 0 = no position	unitless
Sample_ID	GEOTRACES sample number	unitless
Sample_Depth	Depth of sample collection	meters (m)
Ba_D_CONC_FISH_wtoyqq	Dissolved Barium concentrations from tow FISH	nanomoles per kilogram (nmol/kg)
SD1_Ba_D_CONC_FISH_wtoyqq	One standard deviaton of Ba_D_CONC_FISH_wtoyqq	nanomoles per kilogram (nmol/kg)
Flag_Ba_D_CONC_FISH_wtoyqq	Data quality flag for Ba_D_CONC_FISH_wtoyqq	unitless
Ba_D_CONC_UWAY_ththaj	Dissolved Barium concentrations from ship's underway	nanomoles per kilogram (nmol/kg)
SD1_Ba_D_CONC_UWAY_ththaj	One standard deviaton of Ba_D_CONC_UWAY_ththaj	nanomoles per kilogram (nmol/kg)
Flag_Ba_D_CONC_UWAY_ththaj	Data quality flag for Ba_D_CONC_UWAY_ththaj	unitless
Ba_D_CONC_BOTTLE_xhbqq4	Dissolved Barium concentrations from GoFLO bottles	nanomoles per kilogram (nmol/kg)
SD1_Ba_D_CONC_BOTTLE_xhbqq4	One standard deviaton of Ba_D_CONC_BOTTLE_xhbqq4	nanomoles per kilogram (nmol/kg)
Flag_Ba_D_CONC_BOTTLE_xhbqq4	Data quality flag for Ba_D_CONC_BOTTLE_xhbqq4	unitless

## Instruments

<b>Dataset-specific Instrument Name</b>	Super-GeoFISH towed surface vehicle
<b>Generic Instrument Name</b>	GeoFish Towed near-Surface Sampler
<b>Generic Instrument Description</b>	The GeoFish towed sampler is a custom designed near surface (

<b>Dataset-specific Instrument Name</b>	12L GoFlo
<b>Generic Instrument Name</b>	GO-FLO Bottle
<b>Generic Instrument Description</b>	GO-FLO bottle cast used to collect water samples for pigment, nutrient, plankton, etc. The GO-FLO sampling bottle is specially designed to avoid sample contamination at the surface, internal spring contamination, loss of sample on deck (internal seals), and exchange of water from different depths.

<b>Dataset-specific Instrument Name</b>	ThermoScientific iCAP Q
<b>Generic Instrument Name</b>	Inductively Coupled Plasma Mass Spectrometer
<b>Generic Instrument Description</b>	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

## Deployments

RR2214

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/905754">https://www.bco-dmo.org/deployment/905754</a>
<b>Platform</b>	R/V Roger Revelle
<b>Report</b>	<a href="https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/rogerrevelle_rr2214.pdf">https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/rogerrevelle_rr2214.pdf</a>
<b>Start Date</b>	2022-12-01
<b>End Date</b>	2023-01-25
<b>Description</b>	The U.S. GEOTRACES GP17-OCE expedition departed Papeete, Tahiti (French Polynesia) on December 1st, 2022 and arrived in Punta Arenas, Chile on January 25th, 2023. The cruise took place in the South Pacific and Southern Oceans aboard the R/V Roger Revelle with a team of 34 scientists led by Ben Twining (Chief Scientist), Jessica Fitzsimmons, and Greg Cutter (Co-Chief Scientists). GP17 was planned as a two-leg expedition, with its first leg (GP17-OCE) as a southward extension of the 2018 GP15 Alaska-Tahiti expedition and a second leg (GP17-ANT; December 2023-January 2024) into coastal and shelf waters of Antarctica's Amundsen Sea. The GP17-OCE section encompassed three major transects: (1) a southbound pseudo-meridional section (~152-135 degrees West) from 20 degrees South to 67 degrees South; (2) an eastbound zonal transect from 135 degrees West to 100 degrees West; (3) and a northbound section returning to Chile (100-75 degrees West). Additional cruise information is available from the following sources: R2R: <a href="https://www.rvdata.us/search/cruise/RR2214">https://www.rvdata.us/search/cruise/RR2214</a> CCHDO: <a href="https://cchdo.ucsd.edu/cruise/33RR20221201">https://cchdo.ucsd.edu/cruise/33RR20221201</a> More information can also be found at: <a href="https://usgeotraces.ideo.columbia.edu/content/gp17-oce">https://usgeotraces.ideo.columbia.edu/content/gp17-oce</a>

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## Project Information

### **US GEOTRACES GP17-OCE: Investigating the role of the Southern Ocean's biogeochemical divide in shaping the global distributions of radium and barium isotopes (GP17-OCE Ra and Ba isotopes)**

**Coverage:** Subtropical South Pacific, Sub-Antarctic Pacific, and Southern Oceans

#### *NSF Award Abstract:*

The GEOTRACES program aims to understand the distribution of trace elements and their isotopes in the oceans. Trace elements, by their very nature, are scarce. Despite their scarcity, trace elements are valuable tools for studying marine processes, such as: tracking chemical inputs to the ocean from the land or seafloor, identifying patterns of ocean mixing, and tracing ocean biology. This project will study these processes by measuring and modeling the distributions of two chemically similar elements — radium and barium. These measurements will be made on samples collected as part of the U.S. GEOTRACES GP17-OCE expedition. This expedition will collect samples from the Southern Ocean in late 2022. The Southern Ocean experiences deep mixing, which is important for bringing nutrients to the sea surface. Measuring radium and barium isotopes in these samples will help study the sources, cycling, and sinks of nutrients that support marine biology in the Southern Ocean and beyond. The findings will be shared with regional science teachers and students through a collaboration with the local Sea Grant Program, and the data will support the research of other scientists involved in GEOTRACES.

The last 25 years have seen a paradigm shift in our understanding of the controls on marine nutrient cycles. Rather than arising from local vertical processes, the large-scale distributions of many elements are now thought to arise from processes occurring in the Southern Ocean, which are then communicated to lower latitudes through lateral circulation. A circulation-driven mechanism is also hypothesized to contribute to the global distributions of radium and barium isotopes, but this remains to be tested. In this project, researchers from the Woods Hole Oceanographic Institution will test this hypothesis by analyzing radium and barium isotopes in dissolved and particulate samples collected from the Pacific Sector of the Southern Ocean. These measurements will establish compositions for the southern-sourced mode/intermediate and bottom waters that are important end-members in the global overturning circulation. The team will also study the processes that control the composition of the end-members — particle formation and dissolution, interactions with sediments, hydrothermalism — and assess their significance using statistical and mechanistic modeling. The results will reveal the role of the Southern Ocean in controlling the global distributions of radium and barium

isotopes, which will help refine the application of these tracers as tools for studying biogeochemical processes in the present and past oceans.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

## **US GEOTRACES GP17 Section: South Pacific and Southern Ocean (GP17-OCE) (GP17-OCE)**

**Website:** <http://www.geotraces.org/>

**Coverage:** Papeete, Tahiti to Punta Arenas, Chile

The U.S. GEOTRACES GP17-OCE expedition departed Papeete, Tahiti (French Polynesia) on December 1st, 2022 and arrived in Punta Arenas, Chile on January 25th, 2023. The cruise took place in the South Pacific and Southern Oceans aboard the R/V Roger Revelle (cruise ID RR2214) with a team of 34 scientists lead by Ben Twining (Chief Scientist), Jessica Fitzsimmons and Greg Cutter (Co-Chief Scientists). GP17 was planned as a two-leg expedition, with its first leg (GP17-OCE) as a southward extension of the 2018 GP15 Alaska-Tahiti expedition and a second leg (GP17-ANT; December 2023-January 2024) into coastal and shelf waters of Antarctica's Amundsen Sea.

The South Pacific and Southern Oceans sampled by GP17-OCE play critical roles in global water mass circulation and associated global transfer of heat, carbon, and nutrients. Specific oceanographic regions of interest for GP17-OCE included: the most oligotrophic gyre in the global ocean, the Antarctic Circumpolar Current (ACC) frontal region, the previously unexplored Pacific- Antarctic Ridge, the Pacific Deep Water (PDW) flow along the continental slope of South America, and the continental margin inputs potentially emanating from South America.

Further information is available on the [US GEOTRACES website](#) and in the [cruise report](#) (PDF).

*NSF Project Title:* Collaborative Research: Management and Implementation of US GEOTRACES GP17 Section: South Pacific and Southern Ocean (GP17-OCE)

### *NSF Award Abstract:*

This award will support the management and implementation of a research expedition from Tahiti to Chile that will enable sampling for a broad suite of trace elements and isotopes (TEI) across oceanographic regions of importance to global nutrient and carbon cycling as part of the U.S. GEOTRACES program. GEOTRACES is a global effort in the field of Chemical Oceanography, the goal of which is to understand the distributions of trace elements and their isotopes in the ocean. Determining the distributions of these elements and isotopes will increase understanding of processes that shape their distributions, such as ocean currents and material fluxes, and also the processes that depend on these elements, such as the growth of phytoplankton and the support of ocean ecosystems. The proposed cruise will cross the South Pacific Gyre, the Antarctic Circumpolar Current, iron-limited Antarctic waters, and the Chilean margin. In combination with a proposed companion GEOTRACES expedition on a research icebreaker (GP17-ANT) that will be joined by two overlapping stations, the team of investigators will create an ocean section from the ocean's most nutrient-poor waters to its highly-productive Antarctic polar region - a region that plays an outsized role in modulating the global carbon cycle. The expedition will support and provide management infrastructure for additional participating science projects focused on measuring specific external fluxes and internal cycling of TEIs along this section.

The South Pacific Gyre and Pacific sector of the Southern Ocean play critical roles in global water mass circulation and associated global transfer of heat, carbon, and nutrients, but they are chronically understudied for TEIs due to their remote locale. These are regions of strong, dynamic fronts where sub-surface water masses upwell and subduct, and biological and chemical processes in these zones determine nutrient stoichiometries and tracer concentrations in waters exported to lower latitudes. The Pacific sector represents an end member of extremely low external TEI surface fluxes and thus an important region to constrain inputs from the rapidly-changing Antarctic continent. Compared to other ocean basins, TEI cycling in these regions is thought to be dominated by internal cycling processes such as biological uptake, regeneration, and scavenging, and these are poorly represented in global ocean models. The cruise will enable funded investigators to address research questions such as: 1) what are relative rates of external TEI fluxes to this region, including dust, sediment, hydrothermal, and cryospheric fluxes? 2) What are the (micro) nutrient regimes that support productivity, and what impacts do biomass accumulation, export, and regeneration have

on TEI cycling and stoichiometries of exported material? 3) What are TEI and nutrient stoichiometries of subducting water masses, and how do scavenging and regeneration impact these during transport northward? This management project has several objectives: 1) plan and coordinate a 55-day research cruise in 2021-2022; 2) use both conventional and trace-metal 'clean' sampling systems to obtain TEI samples, as well as facilitate sampling for atmospheric aerosols and large volume particles and radionuclides; 3) acquire hydrographic data and samples for salinity, dissolved oxygen, algal pigments, and macro-nutrients; and deliver these data to relevant repositories; 4) ensure that proper QA/QC protocols, as well as GEOTRACES intercalibration protocols, are followed and reported; 5) prepare the final cruise report to be posted with data; 6) coordinate between all funded cruise investigators, as well as with leaders of proposed GP17-ANT cruise; and 7) conduct broader impact efforts that will engage the public in oceanographic research using immersive technology. The motivations for and at-sea challenges of this work will be communicated to the general public through creation of immersive 360/Virtual Reality experiences, via a collaboration with the Texas A&M University Visualization LIVE Lab. Through Virtual Reality, users will experience firsthand what life and TEI data collection at sea entail. Virtual reality/digital games and 360° experiences will be distributed through GEOTRACES outreach websites, through PI engagement with local schools, libraries, STEM summer camps, and adult service organizations, and through a collaboration with the National Academy of Sciences.

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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
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-2048604</a>

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