

GP17-OCE d13C DIC

Website: <https://www.bco-dmo.org/dataset/990510>

Data Type: Cruise Results

Version: 1

Version Date: 2025-12-12

Project

» [US GEOTRACES GP17 Section: South Pacific and Southern Ocean \(GP17-OCE\)](#) (GP17-OCE)

» [US GEOTRACES OCE: Measuring the distribution of stable carbon isotopes and estimating organic matter export rates](#) (GP17-OCE 13C-DIC)

Program

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

Contributors	Affiliation	Role
Quay, Paul	University of Washington (UW)	Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract

This dataset includes measurements of the $^{13}\text{C}/^{12}\text{C}$ ($\delta^{13}\text{C}$) of dissolved inorganic carbon (DIC) in the South Pacific on samples collected during the US GEOTRACES GP17-OCE section (Papeete, Tahiti to Punta Arenas, Chile) on the R/V Roger Revelle from December 2022 to January 2023. The data will be useful to understand the relative contributions of ocean circulation, mixing, and biological pump to determining the observed distribution of dissolved biogeochemical species. These data are the responsibility of Paul Quay at the University of Washington.

Table of Contents

- [Coverage](#)
- [Dataset Description](#)
 - [Methods & Sampling](#)
 - [BCO-DMO Processing Description](#)
 - [Problem Description](#)
- [Parameters](#)
- [Instruments](#)
- [Deployments](#)
- [Project Information](#)
- [Program Information](#)
- [Funding](#)

Coverage

Location: South Pacific

Spatial Extent: N:-19.99984 E:-75.09732 S:-67.00024 W:-152.00026

Temporal Extent: 2022-12-04 - 2023-01-24

Methods & Sampling

Seawater samples for analysis of the $^{13}\text{C}/^{12}\text{C}$ of dissolved inorganic carbon (DIC) were collected in 250 milliliter (ml) ground glass stoppered bottles from Niskin bottles and poisoned with 100 microliters (μl) of mercuric chloride during the cruise.

In the lab, ~50 mls of the seawater sample was acidified and CO_2 extracted using a REDICS system. CO_2 gas was collected cryogenically in a liquid nitrogen cold trap after removal of water vapor and transferred to an isotope ratio mass spectrometer (IRMS) for $^{13}\text{C}/^{12}\text{C}$ measurement. The measured $^{13}\text{C}/^{12}\text{C}$ of the DIC was reported as $\delta^{13}\text{C}$ in units of per mil relative to the PDB standard. The reported uncertainty of the $\delta^{13}\text{C}$

analysis was ± 0.03 per mil determined from repeated measurements of a ab standard and duplicate samples measured during GP17 cruise. The $\delta^{13}\text{C}$ measurements were performed at the NOSAMS facility at WHOI.

BCO-DMO Processing Description

- Converted original file "G17_d13Cdata_BCO_DMO.xlsx" to CSV format.
- Imported file "G17_d13Cdata_BCO_DMO.CSV" into the BCO-DMO system.
- Marked "nd" as a missing data value (missing data are blank/empty in the final CSV file).
- Converted Start_Date_UTC column to YYYY-MM-DD format.
- Converted Start_Time_UTC column to HH:MM format.
- Removed the following empty columns: End_Date_UTC, End_Time_UTC, End_Latitude, End_Longitude
- Saved the final file as "990510_v1_gp17-oce_d13c_dic.csv".

Problem Description

Samples that were not poisoned were eliminated from the dataset.

Quality control flags were assigned to the $\delta^{13}\text{C}$ measurements as follows:

- 2 = good;
- 3 = questionable;
- 4 = bad ;
- 6 = duplicate.

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

Parameters

Parameter	Description	Units
Station_ID	Station number	unitless
Start_Date_UTC	Station start date	unitless
Start_Time_UTC	Station start time	unitless
Start_ISO_DateTime_UTC	Start date and time (UTC) in ISO8601 format	unitless
Start_Latitude	Station latitude start	degrees North
Start_Longitude	Station longitude start	degrees East
Event_ID	Event number	unitless
Sample_ID	GEOTRACES sample number	unitless
Station_Depth	Maximum cast depth	meters (m)
Sample_Pressure	Pressure at Niskin Sample Collection	millibars (mbars)
DIC_13_12_D_Delta_Bottle. This parameter has been registered in the GEOTRACES DOoR system as DIC_13_12_D_DELTA_BOTTLE::ujmclx.	del13C of Dissolved Inorganic Carbon	per mil (vs PDB)
SD1_DIC_13_12_D_Delta_Bottle	One standard deviation of del13C measurement. This parameter has been registered in the GEOTRACES DOoR system as 1SD::DIC_13_12_D_DELTA_BOTTLE::ujmclx.	per mil
Flag_DIC_13_12_D_Delta_Bottle	Quality Control Flag for del13C measurement (2=good; 3=questionable; 4=bad; 6=duplicate). This parameter has been registered in the GEOTRACES DOoR system as Flag::DIC_13_12_D_DELTA_BOTTLE::ujmclx.	unitless

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

Instruments

Dataset-specific Instrument Name	Thermo Delta Q isotope ratio mass spectrometer
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	The $^{13}\text{C}/^{12}\text{C}$ of the CO_2 gas extracted from seawater sample was measured on a Thermo Delta Q isotope ratio mass spectrometer.
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	Niskin bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Seawater samples for analysis of the $^{13}\text{C}/^{12}\text{C}$ of dissolved inorganic carbon (DIC) were collected in 250 ml ground glass stoppered bottles from Niskin bottles and poisoned with 100 μl of mercuric chloride during the cruise.
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.

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

Deployments

RR2214

Website	https://www.bco-dmo.org/deployment/905754
Platform	R/V Roger Revelle
Report	https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/rogerrevelle_rr2214.pdf
Start Date	2022-12-01
End Date	2023-01-25
Description	<p>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: https://www.rvdata.us/search/cruise/RR2214 CCHDO: https://cchdo.ucsd.edu/cruise/33RR20221201 More information can also be found at: https://usgeotraces.ideo.columbia.edu/content/gp17-oce</p>

Project Information

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.

US GEOTRACES OCE: Measuring the distribution of stable carbon isotopes and estimating organic matter export rates (GP17-OCE 13C-DIC)

Coverage: South Pacific and Southern Oceans

NSF Award Abstract:

The goal of this project is to measure the concentration of the rare isotope of carbon (^{13}C) present in the carbon dioxide (CO_2) molecules dissolved in seawater of the South Pacific Ocean. ^{13}C atoms make up only 1% of the carbon atoms on earth whereas atoms with the common carbon isotope (^{12}C) make up 99% of the carbon atoms. Variations in the concentration of ^{13}C atoms are represented relative to the concentration of ^{12}C atoms and expressed as the $^{13}\text{C}/^{12}\text{C}$ ratio. The utility of measuring spatial variations in the $^{13}\text{C}/^{12}\text{C}$ of CO_2 in the ocean results from two observations. First, during photosynthesis the $^{13}\text{C}/^{12}\text{C}$ of the plant (phytoplankton in the ocean) is distinctly different from the $^{13}\text{C}/^{12}\text{C}$ of CO_2 consumed during photosynthesis. Second, the $^{13}\text{C}/^{12}\text{C}$ of CO_2 molecules produced during the combustion of fossil fuels (coal, oil, natural gas) is measurably different from the $^{13}\text{C}/^{12}\text{C}$ of CO_2 in the atmosphere and ocean. As a result, measuring the spatial variations of $^{13}\text{C}/^{12}\text{C}$ of CO_2 in the ocean can be used to estimate variations in the rate of photosynthesis and the rate at which CO_2 produced by fossil fuel combustion is being adsorbed by the ocean. Estimating variations in these two rates are goals of this project.

The $^{13}\text{C}/^{12}\text{C}$ of CO_2 in the ocean depends in large part on the rates of photosynthesis and respiration, which results in spatial covariations in the $^{13}\text{C}/^{12}\text{C}$ of CO_2 , concentrations of primary nutrients (nitrate and phosphate) and trace elements that are used by phytoplankton (e.g., Cadmium). In this project, the planned measurements of the $^{13}\text{C}/^{12}\text{C}$ of CO_2 , nutrients and trace elements during the GEOTRACES GP17 cruise will be used to determine how the north-south variations in biological productivity (photosynthesis and respiration), elemental composition of sinking particles and water mass mixing control the regional variations in the $^{13}\text{C}/^{12}\text{C}$ of CO_2 , nutrients and bioactive trace element distributions in the South Pacific Ocean. An improved understanding of the biological, chemical and physical processes that control spatial variations of $^{13}\text{C}/^{12}\text{C}$ of CO_2 , bioactive trace elements and nutrient distributions in the modern ocean will improve our ability to use $^{13}\text{C}/^{12}\text{C}$ and trace elements measurements on CaCO_3 preserved in the sedimentary record to reconstruct past changes in the ocean circulation and CO_2 cycling in the paleo ocean. The project will involve undergraduate students in the research activities and carry out public outreach through University of Washington, Program on Climate Change (PCC).

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.

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

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.

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

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2048523

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