Silicon stable isotopes for samples collected from surface to depth on the US GEOTRACES GP17-OCE cruise on R/V Roger Revelle (RR2214) from December 2022 to January 2023

Website: https://www.bco-dmo.org/dataset/991532
Data Type: Cruise Results
Version: 1
Version Date: 2026-01-16

Project
» US GEOTRACES GP17 Section: South Pacific and Southern Ocean (GP17-OCE) (GP17-OCE)
» US GEOTRACES GP17-OCE: Evaluating Southern Ocean Control of Global Marine Si Isotope Distribution (GP17-OCE Si Isotopes)

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

Contributors	Affiliation	Role
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Abstract
Silicon isotopes have proven to be a powerful tool for understanding silica cycling on unprecedented spatial and temporal scales in the modern ocean. This dataset contains profiles of silicon isotopes for samples collected from surface to depth at most stations along the GEOTRACES GP17-OCE cruise on R/V Roger Revelle (RR2214), from Tahiti south across the Antarctic Circumpolar Current to 67S, then east towards Chile.

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Coverage

Location: South Pacific and Southern Oceans
Spatial Extent: **N**:-19.99984 **E**:-75.74771 **S**:-67.00024 **W**:-152.00026
Temporal Extent: 2022-12-04 - 2023-01-23

Methods & Sampling

Sampling of silicon (Si) isotopes followed GEOTRACES sampling protocols for Si isotopes (Cutter et al., 2010). Seawater (0.5 to 2 liters (L)) was collected using the conventional CTD rosette. Seawater was filtered directly

from Niskin bottles through silicone tubing plumbed with an inline Acropak filter cartridge (0.8/0.45 micrometer (µm) Supor filter) into acid-cleaned polyethylene bottles. This protocol was used for Si isotopes on previous GEOTRACES cruises. Filtered samples are stored at ambient temperature in the dark and shipped to UCSB for processing.

Silicon preparations were analyzed at UCSB using a Nu Perspective IRMS with a NuSil sample introduction system, following the methods of Brzezinski, et al. (2025). See the Supplemental Files for additional information describing methods.

BCO-DMO Processing Description

- Converted the "data" sheet of original file "RR2214.xlsx" to CSV format.
- Imported the CSV file into the BCO-DMO data processing system.
- Marked "nd" as a missing data value (missing data are empty/blank in the final CSV file).
- Renamed fields to comply with BCO-DMO naming conventions.
- Removed the following empty columns: Gear_ID, End_Date_UTC, End_Time_UTC, End_Latitude, End_Longitude
- Created date-time column in ISO 8601 format.
- Saved the final file as "991532_v1_gp17-oce_silicon_stable_isotopes.csv".

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Related Publications

Brzezinski, M. A., Rablen, S. F., Jones, J. L., Closset, I., & Middleton, J. T. (2025). Automated analysis of natural variations in isotopes of silicon by the thermal decomposition of BaSiF6. Journal of Analytical Atomic Spectrometry, 40(12), 3495–3506. https://doi.org/10.1039/d5ja00294j
Methods

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Parameters

Parameter	Description	Units
Station_ID	Sampling station ID	unitless
Event_ID	R2R eventlog number/Geotraces event number	unitless
Start_ISO_DateTime_UTC	Date and time (UTC) of CTD cast start	unitless
Start_Date_UTC	CTD start date (UTC)	unitless
Start_Time_UTC	CTD start time (UTC)	unitless
Start_Latitude	CTD start latitude in decimal degrees	decimal degrees
Start_Longitude	CTD start longitude in decimal degrees	decimal degrees
Rosette_Position	Niskin/Go-Flo position on CTD rosette	unitless
Sample_ID	Geotraces sample number	unitless
Sample_Depth	Niskin trip depth	meters (m)
SILICATE_30_28_D_DELTA_BOTTLE_t2r8zs	mean delta30Si(OH)4 relative to the NBS28 standard	per mil
SD1_SILICATE_30_28_D_DELTA_BOTTLE_t2r8zs	std dev delta30Si(OH)4 relative to the NBS28 standard	per mil
Flag_SILICATE_30_28_D_DELTA_BOTTLE_t2r8zs	Quality flag: 1 = Good, passed documented required QC tests; 2 = Not evaluated, not available or unknown, used for data when no QC test performed or the information on quality is not available; 3 = Questionable/suspect, failed non-critical documented metric or subjective test(s); 4 = Bad, failed critical documented QC test(s) or as assigned by the data provider; 9 = Missing data, used as a placeholder when data are missing.	unitless

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Instruments

Dataset-specific Instrument Name	Niskin bottle
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Seawater was collected using the conventional 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	Nu Perspective IRMS
Generic Instrument Name	Nu Instruments Perspective Isotope Ratio Mass Spectrometer
Dataset-specific Description	Silicon preparations were analyzed using a Nu Perspective IRMS with a NuSil sample introduction system.
Generic Instrument Description	The Nu Perspective IRMS is a high-performance stable isotope ratio mass spectrometer designed for precise measurements of carbon, nitrogen, oxygen, sulphur, and hydrogen isotopes. It features unique zoom optics with no moving parts, enabling accurate analysis from small sample sizes. The IS variant offers exceptional sensitivity and linearity for clumped isotope analysis. Delta 13C and delta 18O carbonate analysis from

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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	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.ldeo.columbia.edu/content/gp17-oce

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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 GP17-OCE: Evaluating Southern Ocean Control of Global Marine Si Isotope Distribution (GP17-OCE Si Isotopes)

Coverage: South Pacific and Southern Ocean

NSF Award Abstract:
The Southern Ocean around Antarctica is connected to the rest of the global ocean through the meridional overturning circulation. That circulation moves water from the Southern Ocean through the tropics and all the way into the northern hemisphere. Those waters carry nutrient chemicals that fuel the growth of phytoplankton throughout the global ocean whose photosynthetic carbon fixation is a major factor in setting how much atmospheric carbon dioxide is removed by ocean biology. Diatoms are a key group of phytoplankton involved in this process of carbon uptake and they are especially abundant in the Southern Ocean. Diatoms are unique among the phytoplankton because they need the element silicon to grow. They take the silicon (Si) that is dissolved in seawater and use it to produce a shell made of opal called a frustule. In this project we are interested in how the availability of dissolved Si, as set by the Southern Ocean, controls the distribution and abundance of diatoms in the sea and their contribution to ocean biogeochemistry such as the uptake and removal of carbon. We will use a relatively new tool to trace diatom dynamics – silicon isotopes. Variations in silicon isotopes in the dissolved Si in seawater and in diatom frustules can inform the level of diatom growth that has occurred in ocean waters and how diatom growth is coupled to ocean circulation and nutrient transport. The distribution of isotopes of silicon between Tahiti in the tropics to the Southern Ocean

will allow us to better understand how the physics, chemistry and biology of the Southern Ocean controls diatom activity at global scales. The research will involve an early career scientist and undergraduate students at UCSB. The PIs will also reach out to regional K-12 schools through UCSB's Research and Education Experience Facility (REEF) by developing curricula on Southern Ocean biogeochemistry and the GEOTRACES program.

Silicon isotopes will be measured in full ocean depth profiles along US GEOTRACES GP17OCE from Tahiti, French Polynesia to Punta Arenas, Chile. It is now clear that successful application of the Si isotope proxy in the modern ocean and for paleoclimate reconstructions requires a mechanistic understanding of how the silicon isotopic composition of ventilating waters masses varies in time and space. Our goal is to test hypotheses related to predictions from models that processes in the Southern Ocean dictate silicon isotopes distributions throughout the global ocean. That prediction arises because the Southern Ocean is the central hub of the meridional overturning circulation. The interplay between silica production in Southern Ocean surface waters, opal export and the Southern Ocean counter current meridional circulation traps silicic acid in the Southern Ocean while partitioning and redistributing Si isotopes between mode and deep waters. Heavy Si isotopes are distilled out of the Southern Ocean in relatively shallow mode waters while light isotopes ride the northward flow of deep waters. Individual aspects of these predictions have been examined previously; however, measurements of Si isotopes in GP17OCE will provide the first section that samples all relevant water masses synoptically. Those distributions together with other data collected on GP17OCE will allow a more comprehensive evaluation of these mechanisms partitioning Si isotopes in the Southern Ocean and their redistribution in the overturning circulation more globally.

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.

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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-2048998

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