Depth profiles of the isotopic composition (δ30Si) of silicon within dissolved silicic acid from samples collected on Leg 2 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/946249
Data Type: Cruise Results
Version: 1
Version Date: 2024-12-19

Project
» US GEOTRACES Pacific Meridional Transect (GP15) (U.S. GEOTRACES PMT)
» US GEOTRACES Pacific Meridional Transect (GP-15): Resolving Silicon Isotope Anomalies in the Northeast Pacific (PMT Si)

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

Contributors	Affiliation	Role
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Abstract
The isotopic composition of dissolved silicon (δ30Si) has proven to be a powerful tool to better understand the marine Si cycle. The δ30Si of seawater carries information about dissolved silicon utilization in surface waters, the subsequent dissolution of sinking biogenic material as well as water mass mixing. This data set supplies information on the spatial distribution of isotopes of Si within water masses from Tahiti to Alaska along GEOTRACES section GP15. This dataset results from leg 2 of the expedition, RR1815; data from RR1814 are available in a separate BCO-DMO dataset.

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Coverage

Location: Meridional Pacific Ocean
Spatial Extent: **N**:17.5 **E**:-151.9862 **S**:-20 **W**:-152.0082
Temporal Extent: 2018-10-26 - 2018-11-23

Methods & Sampling

Seawater samples for δ30Si measurements were collected using the Oceanographic Data Facilitiy's (ODF, Scripps Institution of Oceanography) CTD-rosette mounted with Niskin samplers and a Sea-Bird Electronics CTD (SBE9plus). Seawater was gravity-filtered into polypropylene containers through in-line Supor filter capsules (0.8/0.45-micrometer (µm)) attached directly to each Niskin bottle. Sample bottles were capped and stored without preservative in the dark.

Back in the laboratory, the silicon from seawater was precipitated off as trimethylamine silicomolybdate using a high-purity triethlyamine ammonium molybdate solution (TEA-Moly). The precipitate was isolated by filtration onto a polycarbonate filter and purified by high-temperature combustion to produce solid silicon dioxide. SiO2 was then converted to solid Cs2SiF6 by dissolution in HF and addition of CsCl. The Cs2SiF6 was rinsed with ethanol, dried, and dissolved in high purity (>18MΩ) water. BaSiF6 was precipitated by the addition of BaCl, rinsed with ethanol and dried.

Isotopic ratio analysis was performed using a Nu Perspective isotope ratio mass spectrometer equipped with a Nu Sil inlet system. Samples of BaSiF6 are loaded into sample vials that are placed in a sample carousel in the Nu Sil. Samples are sequentially heated to 590 degrees Celsius (°C) to evolve.

Isotope delta values are normalized against the international standard NBS28.

Methods are further described in the Supplemental File "Natural_Abundance_Protocol.pdf".

Data Processing Description

Depths (represented as pressure in decibars), date-times, and locations (lat/lon) in the dataset were obtained from the cruise's CTD bottle file based on the unique GEOTRACES sample number for each sample. However, there were sometimes multiple bottles tripped for a single GEOTRACES sample number. In those cases, if the Niskin/Go-Flo number was also recorded by the data provider, the metadata information for that bottle was used. If the Niskin/Go-Flo number was not recorded along with the GEOTRACES number, the rosette bottle number that had both O2 and salinity data was used to obtain the metadata information for the sample, as advised by the cruise's lead PIs.

Quality flags were assigned according to the following definitions:

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 place holder when data are missing.

BCO-DMO Processing Description

- Imported original file "RR1815_silicon.xlsx" into the BCO-DMO system.
- Marked "nd", "no data", "#N/A" , and "small n" as missing data values (missing data values are empty/blank in the final CSV file).
- Renamed fields to comply with BCO-DMO naming conventions.
- Created date-time field in ISO 8601 format.
- Rounded values in the SILICATE_30_28_D_DELTA_BOTTLE_1foxwp and SD1_SILICATE_30_28_D_DELTA_BOTTLE_1foxwp columns to 3 decimal places.
- Removed the following empty columns: End_Date_UTC, End_Time_UTC, End_Latitude, End_Longitude.
- Saved the final file as "946249_v1_gp15_delta30si_leg2.csv".

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Data Files

File	
946249_v1_gp15_delta30si_leg2.csv	(Comma Separated Values (.csv), 26.93 KB) MD5:0f5495df01d62f74ce07af67b7ffccf3
Primary data file for dataset ID 946249, version 1	

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Supplemental Files

File
Natural_Abundance_Protocol.pdf (Portable Document Format (.pdf), 284.37 KB) MD5:9220bce254d78da1714d456b5bed38ae Supplemental file for dataset IDs 946242 (version 1) and 946249 (version 1).

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Related Datasets

Continues

Brzezinski, M. A. (2024) **Depth profiles of the isotopic composition (δ30Si) of silicon within dissolved silicic acid from samples collected on Leg 1 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 1) Version Date 2024-12-19 doi:10.26008/1912/bco-dmo.946242.1 [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	sampling station	unitless
Start_Date_UTC	cast date	unitless
Start_Time_UTC	cast time (UTC)	unitless
Start_ISO_DateTime_UTC	cast date and time (UTC) in ISO 8601 format	unitless
Start_Latitude	cast latitude (negative values = South)	decimal degrees
Start_Longitude	cast longitude (negative values = West)	decimal degrees
Event_ID	GEOTRACES event number	unitless
Sample_ID	GEOTRACES sample number	unitless
Sample_Depth	Pressure at depth of sample collected; obtained from CTD data provided by from chief scientist	decibars (db)
SILICATE_30_28_D_DELTA_BOTTLE_1foxwp	mean delta30Si(OH)4 relative to the NBS28 standard	per mil
SD1_SILICATE_30_28_D_DELTA_BOTTLE_1foxwp	Standard deviation of SILICATE_30_28_D_DELTA_BOTTLE_1foxwp	per mil
Flag_SILICATE_30_28_D_DELTA_BOTTLE_1foxwp	Quality flag for SILICATE_30_28_D_DELTA_BOTTLE_1foxwp	unitless

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Instruments

Dataset-specific Instrument Name	Nu Perspective isotope ratio mass spectrometer
Generic Instrument Name	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 on the GEOTRACES ODF CTD-rosette system
Generic Instrument Name	Niskin bottle
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.

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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.

US GEOTRACES Pacific Meridional Transect (GP-15): Resolving Silicon Isotope Anomalies in the Northeast Pacific (PMT Si)

NSF Award Abstract:
This project will examine the distribution of isotopes of the element silicon in the Pacific Ocean to gain insights into processes that control the movement of silicon through the global ocean. Such studies are motivated by the fact that the silicon that is dissolved in seawater supports the growth of diatoms. Diatoms are microscopic algae that use silicon to produce ornately sculpted shells called frustules. Diatoms are unique in that they are the only major group of marine photosynthetic microbes that need silicon in order to grow. Diatoms are responsible for 20% of the total photosynthesis on Earth so we can each thank a diatom for every fifth breath of oxygen that we breathe. The sheer scale of their contribution makes understanding what controls their distribution and abundance important for the ecology and chemistry of the oceans and for society. Their need for silicon means that the amount of silicon dissolved in seawater can control where diatoms grow and how many are produced. Diatoms obtain silicon, and other nutrient fertilizer, when currents bring deep waters that are rich in these nutrients to the surface ocean. This project will investigate how the stable isotopic composition of dissolved silicon varies in the Pacific Ocean. Why bother with isotopes? It turns out that diatoms preferentially use lighter isotopes of silicon when building their frustules. This produces signals in diatom frustules and in the dissolved silicon in the sea that allows isotopes to be used to reconstruct diatom productivity in the past. The isotopic composition of the dissolved silicon in deep ocean waters is different in different ocean basins. These differences in isotopes of silicon in deep waters appear to be systematic and are tied to the movement of currents in the deep sea. Once these patterns are understood evaluations of diatom productivity based on isotopes will improve enormously. Testing the relationship between isotopes of silicon and the water masses that comprise the deep circulation of the global ocean is a major goal of this study.

This study will take place as part of the 2018 GEOTRACES expedition from Alaska to Tahiti. This expedition will sample several important water masses. The deep waters of the northeast Pacific are among the most puzzling relative to current understanding of the processes controlling Si isotope distributions. Deep waters of the north Pacific possess the highest concentration of dissolved silicon and oldest waters at the "end" of the global deep water circulation. Moreover, the northeast Pacific is of particular interest as it contains what could be the largest silicon isotope anomaly in the global ocean, known as the North Pacific Silicic Acid Plume. The plume, as its name implies, consists of a tongue of elevate dissolved silicon that extends from the Cascadia Basin off North America nearly to Japan. The limited data available so far implies that isotope patterns across the plume are the opposite of model predictions challenging our current understanding of controls on Si isotope distributions. Elsewhere, the planned expedition will intersect key water masses including surface waters, North Pacific Intermediate Water, North Pacific Deep Water, and at the southern extreme of the section, Antarctic Intermediate Water and Circumpolar Deep Water allowing tests of hypotheses on how silicon isotope relate to the distribution of deep water masses in the Pacific. Examining these features will involve sampling seawater using the logistical support from the GEOTRACES management team. Seawater will be collected from the surface to near ocean bottom at twelve stations between Tahiti and Alaska targeting key water masses and the North Pacific Plume. Samples of diatom frustules from throughout the water column will be collected at three stations to explore fractionation of silicon during the dissolution of diatoms frustules. This project will also provide partial support for a postdoctoral scholar who will both participate in the science and also collaborate with the principal investigator on disseminating the discoveries to the public.

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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-1732139

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