Depth profiles of the isotopic composition (d30Si) of silicon within dissolved silicic acid on the US GEOTRACES Arctic cruise GN01 (HLY1502) from August to October 2015

Website: https://www.bco-dmo.org/dataset/809612
Data Type: Cruise Results
Version: 1
Version Date: 2020-04-17

Project
» U.S. Arctic GEOTRACES Study (GN01) (U.S. GEOTRACES Arctic)
» GEOTRACES Arctic Section: Diagnosing the unique silicon isotope composition of the Arctic Ocean (GEOTRACES Arctic Si Isotopes)

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 DSi 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 in the Arctic Ocean from the Bering Strait to the north pole. Profiles of silicon isotopes within silicic acid, δ30Si(OH)4, were obtained at a total of 15 stations on the GEOTRACES GN01 cruise

Table of Contents

Coverage

Spatial Extent: **N**:89.9876 **E**:179.3519 **S**:65.8093 **W**:-179.8086
Temporal Extent: 2015-08-16 - 2015-10-07

Methods & Sampling

Samples collected from Niskin bottles using the GEOTRACES ODF CTD-rosette system. (Note on niskin trip depths reported in dataset: multiple bottles were tripped to collect sample water; these samples were linked to the Niskin number having both oxygen and salinity bottle data.)

Seawater samples for δ30Si measurements were collected using a 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 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 of 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 as BaSiF6 are loaded into sample vials that are placed in a sample carousel in the Nu Sil. Samples are sequentially heated to 590°C.

Isotope delta values are normalized against the international standard NBS28.

For more information, see the Protocol document (under Supplemental Files).

Data Processing Description

Data are flagged with the following quality flags:
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:
- modified parameter names;
- formatted dates to yyyy-mm-dd and times to HH:MM;
- added date/time fields in ISO 8601 format.

[table of contents | back to top]

Data Files

File
Si_isotopes.csv (Comma Separated Values (.csv), 32.96 KB) MD5:b7b054b6191707d6aa97e6c0425614ec Primary data file for dataset ID 809612

[table of contents | back to top]

Supplemental Files

File
Brzezinski Lab Si Natural Abundance Protocols filename: Natural_Abundance_Protocol.pdf (Portable Document Format (.pdf), 132.70 KB) MD5:eef6447879df1c705bd3a8858177e388 Brzezinski Lab Si Natural Abundance Preparation Protocols

[table of contents | back to top]

Parameters

Parameter	Description	Units
Station_ID	Sampling station	unitless
Start_Date_UTC	CTD start date (UTC); format: yyyy-mm-dd	unitless
Start_Time_UTC	CTD start time (UTC); format: HH:MM	unitless
Start_ISO_DateTime_UTC	CTD start date and time (UTC) in ISO8601 format: yyyy-mm-ddTHH:MMZ	unitless
End_Date_UTC	CTD end date (UTC); format: yyyy-mm-dd	unitless
End_Time_UTC	CTD end time (UTC); format: HH:MM	unitless
End_ISO_DateTime_UTC	CTD end date and time (UTC) in ISO8601 format: yyyy-mm-ddTHH:MMZ	unitless
Start_Latitude	CTD start latitude in decimal degrees	decimal degrees
Start_Longitude	CTD start longitude in decimal degrees	decimal degrees
End_Latitude	CTD end latitude in decimal degrees	decimal degrees
End_Longitude	CTD end longitude in decimal degrees	decimal degrees
Event_ID	Geotraces event number	unitless
Sample_ID	Geotraces sample number	unitless
Sample_Depth	Niskin trip depth. Multiple bottles were tripped to collect sample water; our samples were linked to the Niskin number having both oxygen and salinity bottle data.	meters (m)
SILICATE_30_28_D_DELTA_BOTTLE_5ib7da	mean delta30Si(OH)4 relative to the NBS28 standard	per mil
SD1_SILICATE_30_28_D_DELTA_BOTTLE_5ib7da	std dev delta30Si(OH)4 relative to the NBS28 standard	per mil
Flag_SILICATE_30_28_D_DELTA_BOTTLE_5ib7da	quality flag for SILICATE_30_28_D_DELTA_BOTTLE_5ib7da: 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.	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	SBE9plus
Generic Instrument Name	CTD Sea-Bird
Dataset-specific Description	Seawater samples for δ30Si measurements were collected using a Oceanographic Data Facilitiy's (ODF, Scripps Institution of Oceanography) CTD-rosette mounted with Niskin samplers and a Sea-Bird Electronics CTD (SBE9plus).
Generic Instrument Description	Conductivity, Temperature, Depth (CTD) sensor package from SeaBird Electronics, no specific unit identified. This instrument designation is used when specific make and model are not known. See also other SeaBird instruments listed under CTD. More information from Sea-Bird Electronics.

Dataset-specific Instrument Name	Nu Perspective isotope ratio mass spectrometer
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	Isotopic ratio analysis was performed using a Nu Perspective isotope ratio mass spectrometer equipped with a Nu Sil inlet system.
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	
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Samples were collected from Niskin bottles using the GEOTRACES ODF CTD-rosette system.
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

HLY1502

Website	https://www.bco-dmo.org/deployment/638807
Platform	USCGC Healy
Report	https://datadocs.bco-dmo.org/docs/302/geotraces/GEOTRACES_ARCTIC/data_docs/cruise_reports/healy1502.pdf
Start Date	2015-08-09
End Date	2015-10-12
Description	Arctic transect encompassing Bering and Chukchi Shelves and the Canadian, Makarov and Amundsen sub-basins of the Arctic Ocean. The transect started in the Bering Sea (60°N) and traveled northward across the Bering Shelf, through the Bering Strait and across the Chukchi shelf, then traversing along 170-180°W across the Alpha-Mendeleev and Lomonosov Ridges to the North Pole (Amundsen basin, 90°N), and then back southward along ~150°W to terminate on the Chukchi Shelf (72°N). Additional cruise information is available in the GO-SHIP Cruise Report (PDF) and from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/HLY1502

[table of contents | back to top]

Project Information

U.S. Arctic GEOTRACES Study (GN01) (U.S. GEOTRACES Arctic)

Website: https://www.geotraces.org/

Coverage: Arctic Ocean; Sailing from Dutch Harbor to Dutch Harbor (GN01)

Description from NSF award abstract:
In pursuit of its goal "to identify processes and quantify fluxes that control the distributions of key trace elements and isotopes in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions", in 2015 the International GEOTRACES Program will embark on several years of research in the Arctic Ocean. In a region where climate warming and general environmental change are occurring at amazing speed, research such as this is important for understanding the current state of Arctic Ocean geochemistry and for developing predictive capability as the regional ecosystem continues to warm and influence global oceanic and climatic conditions. The three investigators funded on this award, will manage a large team of U.S.scientists who will compete through the regular NSF proposal process to contribute their own unique expertise in marine trace metal, isotopic, and carbon cycle geochemistry to the U.S. effort. The three managers will be responsible for arranging and overseeing at-sea technical services such as hydrographic measurements, nutrient analyses, and around-the-clock management of on-deck sampling activites upon which all participants depend, and for organizing all pre- and post-cruise technical support and scientific meetings. The management team will also lead educational outreach activities for the general public in Nome and Barrow, Alaska, to explain the significance of the study to these communities and to learn from residents' insights on observed changes in the marine system. The project itself will provide for the support and training of a number of pre-doctoral students and post-doctoral researchers. Inasmuch as the Arctic Ocean is an epicenter of global climate change, findings of this study are expected to advance present capability to forecast changes in regional and globlal ecosystem and climate system functioning.

As the United States' contribution to the International GEOTRACES Arctic Ocean initiative, this project will be part of an ongoing multi-national effort to further scientific knowledge about trace elements and isotopes in the world ocean. This U.S. expedition will focus on the western Arctic Ocean in the boreal summer of 2015. The scientific team will consist of the management team funded through this award plus a team of scientists from U.S. academic institutions who will have successfully competed for and received NSF funds for specific science projects in time to participate in the final stages of cruise planning. The cruise track segments will include the Bering Strait, Chukchi shelf, and the deep Canada Basin. Several stations will be designated as so-called super stations for intense study of atmospheric aerosols, sea ice, and sediment chemistry as well as water-column processes. In total, the set of coordinated international expeditions will involve the deployment of ice-capable research ships from 6 nations (US, Canada, Germany, Sweden, UK, and Russia) across different parts of the

Arctic Ocean, and application of state-of-the-art methods to unravel the complex dynamics of trace metals and isotopes that are important as oceanographic and biogeochemical tracers in the sea.

GEOTRACES Arctic Section: Diagnosing the unique silicon isotope composition of the Arctic Ocean (GEOTRACES Arctic Si Isotopes)

NSF Award Abstract:
An investigator will participate in the 2015 U.S. GEOTRACES Arctic Ocean expedition and measure silicon isotopes composition of silicic acid in seawater samples, as well as diatoms and sea ice. In common with other multinational initiatives in the International GEOTRACES program, the goals of the U.S. Arctic expedition are to identify processes and quantify fluxes that control the distributions of key trace elements and isotopes in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions. Some trace elements are essential to life, others are known biological toxins, and still others are important because they can be used as tracers of a variety of physical, chemical, and biological processes in the sea. As silicon is a key component of diatom shells, the measurement of their concentrations in this study can provide an important indicator of primary productivity, both in the present day, as well as past oceans. The project will provide training for undergraduate students and a post-doctoral researcher in silicon chemistry, as well as include outreach to K-12 students.

The silicon isotope proxy is increasingly being used to assess the role of diatoms and silicic acid supply to past shifts in ocean productivity and their role in Earth's climate. Application of the proxy requires knowledge of the silicon isotopic composition of ventilating water masses. Uncertainty in these values translates directly into uncertainty in the level of productivity implied by the proxy. The growing global data set of silicon isotopes in marine waters suggest that silicon isotopes in subsurface waters are not uniform, but vary systematically driven by interactions between silicon isotope fractionation, the biological pump and thermohaline circulation. In addition, significant anomalies exist between model predictions and observations. In this study, researchers will test hypotheses regarding the origin of this signal and the mechanisms controlling silicon isotope distributions within the Arctic Ocean by greatly expanding the silicon isotope data set for this region. The overarching hypothesis to be tested is that silicon isotope distributions are controlled by the coupling of silicon fractionation during silica production and during silica dissolution to the biological pump and to the meridional overturning circulation.

[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-1434305

[table of contents | back to top]