

The ratio of ^{13}C to ^{12}C of dissolved inorganic carbon (DIC) measured during the GEOTRACES Arctic cruise (HLY 1502, ARC01) during Fall 2015

Website: <https://www.bco-dmo.org/dataset/751211>

Data Type: Cruise Results

Version: 2

Version Date: 2019-09-20

Project

» [U.S. Arctic GEOTRACES Study \(GN01\)](#) (U.S. GEOTRACES Arctic)

» [US GEOTRACES ARCTIC: Measuring stable isotopes of carbon in dissolved inorganic carbon and oxygen/argon gas ratios to show impact of organic matter export on nutrient distributions](#) (GEOTRACES Arctic del13C)

Program

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

Contributors	Affiliation	Role
Quay, Paul	University of Washington (UW)	Principal Investigator
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Abstract

The ratio of ^{13}C to ^{12}C of dissolved inorganic carbon (DIC) measured during the GEOTRACES Arctic cruise (HLY 1502, ARC01) during Fall 2015.

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Coverage

Spatial Extent: N:89.9876 E:179.1997 S:60.252 W:-179.8934

Temporal Extent: 2015-08-12 - 2015-10-07

Methods & Sampling

The seawater samples were collected by transferring water from a Niskin bottle into a pre-washed and pre-baked Pyrex 250ml bottle with a ground glass top. The water was overflowed for at least one bottle volume. The sample was poisoned by adding 100uL of saturated HgCl_2 solution. A greased glass stopper was inserted and rotated to insure an air tight seal. The bottle was stored at room temperature. Tests in the lab have indicated that a sample collected correctly can be stored for more than 1 year without significant offset in the $\delta^{13}\text{C}$ value.

The $\delta^{13}\text{C}$ value of dissolved inorganic carbon (DIC) in seawater was measured by: (i) drawing the seawater

sample into an evacuated gravimetrically calibrated burette; (ii) transferring the sample to a helium bubbler; (iii) acidifying with 50% phosphoric acid; (iv) stripping with 99.999% pure He at a flow rate of 40 cubic cm per minute for 30 minutes and collecting the CO₂ at -196 °C, after trapping out water at -78 °C. The d13C of the CO₂ gas was measured on a Thermo Scientific MAT253 isotope ratio mass spectrometer. The N₂O correction was less than 0.02 ‰ based on the measured mass 30/44 ratio. The d13C value is reported in per mil units (‰) relative to PDB based on working lab standards calibrated against NBS-19. The overall precision of d13C measurement was ±0.03 ‰ based on measured duplicate samples.

For complete sampling and analytical methodologies, refer to Quay et al. 2003.

Data Processing Description

BCO-DMO Processing:

- modified parameter names to conform with BCO-DMO and GEOTRACES naming conventions;
- removed spaces in front of values;
- formatted time to HHMM;
- 20-Sept-2019: replaced previous version of data (02-Jan-2019) with version received 16-Aug-2019.

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Data Files

File
d13C_DIC.csv (Comma Separated Values (.csv), 34.49 KB) MD5:a3701b71b779f32fa93d3b0bf1abf01d Primary data file for dataset ID 751211

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Related Publications

Quay, P., Sonnerup, R., Westby, T., Stutsman, J., & McNichol, A. (2003). Changes in the¹³C/¹²C of dissolved inorganic carbon in the ocean as a tracer of anthropogenic CO₂uptake. *Global Biogeochemical Cycles*, 17(1), 4-1-4-20. doi:10.1029/2001gb001817 <https://doi.org/10.1029/2001GB001817>
Methods

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Parameters

Parameter	Description	Units
EXPCODE	Cruise identifier	unitless
SECT_ID	GO SHIP Cruise Identifier	unitless
GEOTRC_EVENTNO	GEOTRACES event number	unitless
STNNBR	Station number	unitless
CASTNO	Cast number	unitless
Coll_Date	Sample collection date. Format: yyyyymmdd	unitless
TIME	Sample collection date. Format: HHMM	unitless
LATITUDE	Latitude	decimal degrees
LONGITUDE	Longitude (- value = W; + value = East)	decimal degrees
GEOTRC_SAMPNO	GEOTRACES sample number	unitless
SAMPNO	Sample number	unitless
BTLNBR	Niskin bottle number	unitless
BTLNBR_FLAG_W	QC flag for bottle performance	unitless
Depth	Sample depth	meters (m)
DIC_13_12_D_DELTA_BOTTLE	delta13C in per mil units relative to PDB	per mil
DIC_13_12_D_DELTA_BOTTLE_FLAG	QC flag for DIC_13_12_D_DELTA_BOTTLE (2=good, 3=questionable, 4=bad and 6 = duplicate)	unitless

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Instruments

Dataset-specific Instrument Name	Thermo Scientific MAT253
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	The d13C of the CO2 gas was measured on a Thermo Scientific MAT253 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 bottle
Generic Instrument Name	Niskin bottle
Dataset-specific Description	The seawater samples were collected by transferring water from a Niskin bottle into a pre-washed and pre-baked Pyrex 250ml bottle with a ground glass top.
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

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

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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 activities 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 global 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.

US GEOTRACES ARCTIC: Measuring stable isotopes of carbon in dissolved inorganic carbon and oxygen/argon gas ratios to show impact of organic matter export on nutrient distributions (GEOTRACES Arctic $\delta^{13}C$)

Coverage: Arctic

NSF Award Abstract:

A scientist from the University of Washington will participate in the 2015 U.S. GEOTRACES Arctic Ocean cruise and measure the vertical distribution of the stable isotopes of carbon found in dissolved inorganic carbon ($\delta^{13}C$), a tracer of biogeochemical cycling. In addition, he will determine the spatial variation in the ratio of oxygen gas to argon gas (O_2/Ar) in surface water samples because this ratio can be used as a proxy for organic matter export. 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. Results from this study will further our understanding of the processes that control observed trace elements, nutrients, and the stable carbon isotopes in dissolved inorganic carbon in the present day ocean and use this information to gain information on past changes in ocean circulation on carbon cycling. This project will also provide training opportunities for undergraduate students, and results will be integrated into public outreach activities and material for class lectures.

A better understanding of the impact of physical and biological processes on the distribution of nutrient and trace elements in the modern ocean is critical to our interpretation of future changes in their distributions in the Arctic and their utility as proxies of circulation and biological pump conditions in the historic ocean. One key parameter needed to understand these processes is $\delta^{13}C$ of dissolved inorganic carbon, for which little to no data currently exists in the Arctic Ocean. This study will aim to measure the depth distribution of the $\delta^{13}C$ of dissolved inorganic carbon and the dissolved O_2/Ar ratio in the surface layer of the ocean. These measurements will help to quantify the contributions of chemical processes and the biological pump on the spatial distribution of nutrients, trace elements, and $\delta^{13}C$, as well as estimate organic matter export rates from the surface ocean.

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.

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1433349