Nitrate N and O isotope ratios from CTD niskin depth profiles collected along section HLY1502-GN01 in the Western Arctic Ocean from August to October 2015

Website: https://www.bco-dmo.org/dataset/733109
Data Type: Cruise Results
Version: 2
Version Date: 2020-07-09

Project
» U.S. Arctic GEOTRACES Study (GN01) (U.S. GEOTRACES Arctic)
» Collaborative Research: GEOTRACES Arctic Ocean section-Constraining Nitrogen Cycling in the western Arctic Ocean. (US GEOTRACES Arctic Nitrogen Flux)

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

Contributors	Affiliation	Role
Granger, Julie	University of Connecticut (UConn)	Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
High precision measurements of Nitrogen (15N/14N) and Oxygen (18O/16O) isotope ratios in depth profiles along the GEOTRACES transect to the western Arctic Ocean (HLY1502-GN01) were made in order to trace nitrogen cycling in different parts of the basin and within different water masses. Nitrate isotope ratio analyses were performed by Richard Dabundo in the Granger Laboratory at the University of Connecticut.

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Coverage

Spatial Extent: **N**:89.9876 **E**:179.1997 **S**:60.252 **W**:-179.8086
Temporal Extent: 2015-08-12 - 2015-10-05

Dataset Description

Isotope ratios of N and O in nitrate from US GEOTRACES-Arctic cruise HLY1502 in 2015.

Methods & Sampling

Seawater samples for nitrate isotope analyses were filtered through a 0.2-um pore-size polyethersulfone membrane into pre-rinsed 60-ml high density polyethylene bottles and were stored frozen until analysis.

The naturally occurring isotope ratios of nitrogen (15N/14N) and oxygen (18O/16O) in nitrate (NO3-) were analyzed by the denitrifier method (Casciotti et al., 2002; Sigman et al., 2001). Briefly, 20 nmol of NO3- were quantitatively reduced to nitrous oxide (N2O) gas by denitrifying bacteria that lack an active terminal N2O reductase (P. chlororaphis f. sp. aureofaciens; ATCC #13985). The product N2O was analyzed by continuous flow isotope ratio mass spectrometry on a Thermo Delta V Advantage isotope ratio mass spectrometer interfaced with a purpose-built, gas chromatography-based device for N2O extraction, concentration, and purification (Casciotti et al., 2002; McIlvin & Casciotti, 2011). Nitrite (NO2-), which interferes with the NO3- isotope analyses, was removed from samples with sulfamic acid (Granger & Sigman, 2009) prior to analysis in the few samples where it was detected. Individual analyses were referenced to injections from a laboratory standard N2O tank and calibrated using the NO3- reference materials IAEA-N3 (4.7‰vs. N2 and 25.6‰vs. VSMOW; Böhlke et al., 2003; Gonfiantiniet al., 1995) and U.S. Geological Survey-34 (+1.8‰vs. N2; -27.9‰vs. VSMOW; Böhlke et al., 2003), with monitoring of reproducibility by analysis of an internal seawater NO3- standard from the deep North Atlantic. NO3- standards in individual runs were diluted in nutrient-free seawater to concentrations equivalent to those of samples to account for potential matrix effects on δ18ONO3 measurements (Weigand et al., 2016). In order to ensure measurement accuracy, samples were analyzed in duplicate within runs, for a minimum of three discrete runs, yielding average standard deviations of 0.2‰ for N and 0.3‰ for O, although with a lower precision averaging 0.4‰ for δ18ONO3 at lower NO3- concentrations (<10 µM).

Data Processing Description

BCO-DMO Processing:
- re-formatted time so values are all 4 digits;
- added date/time columns in ISO8601 format;
- renamed fields.

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Data Files

File	
Nitrate_Isotopes.csv	(Comma Separated Values (.csv), 29.00 KB) MD5:f0c4659da394f07babbfccbd4807ce37
Primary data file for dataset ID 733109	

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Related Publications

Böhlke, J. K., Mroczkowski, S. J., & Coplen, T. B. (2003). Oxygen isotopes in nitrate: new reference materials for18O:17O:16O measurements and observations on nitrate-water equilibration. Rapid Communications in Mass Spectrometry, 17(16), 1835–1846. doi:10.1002/rcm.1123
Methods

Casciotti, K. L., Sigman, D. M., Hastings, M. G., Böhlke, J. K., & Hilkert, A. (2002). Measurement of the Oxygen Isotopic Composition of Nitrate in Seawater and Freshwater Using the Denitrifier Method. Analytical Chemistry, 74(19), 4905–4912. doi:10.1021/ac020113w
Methods

Gonfiantini, R., Stichler, W., & Rozanski, K. (1995). Standards and intercomparison materials distributed by the International Atomic Energy Agency for stable isotope measurements (IAEA-TECDOC--825). International Atomic Energy Agency (IAEA)
Methods

Granger, J., & Sigman, D. M. (2009). Removal of nitrite with sulfamic acid for nitrate N and O isotope analysis with the denitrifier method. Rapid Communications in Mass Spectrometry, 23(23), 3753–3762. doi:10.1002/rcm.4307
Methods

McIlvin, M. R., & Casciotti, K. L. (2011). Technical Updates to the Bacterial Method for Nitrate Isotopic Analyses. Analytical Chemistry, 83(5), 1850–1856. doi:10.1021/ac1028984
Methods

Sigman, D. M., Casciotti, K. L., Andreani, M., Barford, C., Galanter, M., & Böhlke, J. K. (2001). A Bacterial Method for the Nitrogen Isotopic Analysis of Nitrate in Seawater and Freshwater. Analytical Chemistry, 73(17), 4145–4153. doi:10.1021/ac010088e
Methods

Weigand, M. A., Foriel, J., Barnett, B., Oleynik, S., & Sigman, D. M. (2016). Updates to instrumentation and protocols for isotopic analysis of nitrate by the denitrifier method. Rapid Communications in Mass Spectrometry, 30(12), 1365–1383. doi:10.1002/rcm.7570
Methods

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Parameters

Parameter	Description	Units
Station_ID	Station number	unitless
CASTNO	Cast number	unitless
Start_Date_UTC	Sampling start date (UTC); format: YYYYMMDD	unitless
Start_Time_UTC	Sampling start time (UTC); format: hh:mm	unitless
Start_ISO_DateTime_UTC	Sampling start date/time (UTC) formatted to ISO8601 standard: YYYY-MM-DDThh:mmz	unitless
End_Date_UTC	Sampling end date (UTC); format: YYYYMMDD	unitless
End_Time_UTC	Sampling end time (UTC); format: hh:mm	unitless
Start_Latitude	Sampling start latitude	decimal degrees North
Start_Longitude	Sampling start longitude	decimal degrees East
End_Latitude	Sampling end latitude	decimal degrees North
End_Longitude	Sampling end longitude	decimal degrees East
Event_ID	GEOTRACES event number	unitless

Sample_ID	GEOTRACES sample number	unitless
Sample_Depth	Sample depth	meters (m)
NITRATE_15_14_D_DELTA_BOTTLE_qwo9pn	Atom ratio of dissolved N isotopes in NITRATE expressed in conventional DELTA notation referenced to Air N2, samples may or may not have been filtered	per mil
SD1_NITRATE_15_14_D_DELTA_BOTTLE_qwo9pn	One standard deviation of NITRATE_15_14_D_DELTA_BOTTLE_qwo9pn	per mil
Flag_NITRATE_15_14_D_DELTA_BOTTLE_qwo9pn	Quality flag for NITRATE_15_14_D_DELTA_BOTTLE_qwo9pn	unitless
NITRATE_18_16_D_DELTA_BOTTLE_qmffoc	Atom ratio of dissolved O isotopes in NITRATE expressed in conventional DELTA notation referenced to {VSMOW}, samples may or may not have been filtered	per mil
SD1_NITRATE_18_16_D_DELTA_BOTTLE_qmffoc	One standard deviation of NITRATE_18_16_D_DELTA_BOTTLE_qmffoc	per mil
Flag_NITRATE_18_16_D_DELTA_BOTTLE_qmffoc	Quality flag for NITRATE_18_16_D_DELTA_BOTTLE_qmffoc	unitless

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Instruments

Dataset-specific Instrument Name	GC-IRMS
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	The product N2O was analyzed by continuous flow isotope ratio mass spectrometry on a Thermo Delta V Advantage isotope ratio mass spectrometer interfaced with a purpose-built, gas chromatography-based device for N2O extraction, concentration, and purification.
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	Water samples from Niskin bottles were filtered through 0.2 µm pore-size PES membrane filter and stored frozen in acid-washed 60 mL HDPE bottles.
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 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.

Collaborative Research: GEOTRACES Arctic Ocean section-Constraining Nitrogen Cycling in the western Arctic Ocean. (US GEOTRACES Arctic Nitrogen Flux)

Coverage: Chukchi shelf and western Arctic Ocean basins

In this project, a group of investigators from the University of Connecticut, the University of Massachusetts-Dartmouth, and Brown University will participate in the 2015 U.S. GEOTRACES Arctic expedition to determine the biogeochemistry of nitrogen in the region. 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. Nitrogen is one of the two major nutrients required universally by plankton in the ocean, and this study in the Arctic Ocean will increase our understanding of the ocean?s ecology, productivity, and carbon cycle. This study will also provide training for graduate and undergraduate students, and results will be shared through public outreach events.

The state of knowledge of Arctic nitrogen (N) biogeochemistry remains cursory as compared to that in other ocean basins despite the fact that understanding Arctic Ocean nitrogen cycling is central to understanding its global biogeochemistry. For one, benthic nitrogen loss on Arctic continental shelves may represent a globally significant sink of oceanic fixed nitrogen. Second, benthic nitrogen loss on the Arctic continental shelf and slope reduces the ratio of nitrate to phosphate substantially below the mean requirements of phytoplankton nitrogen, consequently limiting primary production at the ice-free surface of the western Arctic Ocean. In light of the rapid changes in Arctic climatology, the characterization of its biogeochemistry and establishment of a baseline from which to monitor future changes is critical. Researchers will use the stable N isotope (15N/14N) ratio in nitrate, nitrite, ammonium, and nitrogen gas determined for a suite of dissolved, particulate, atmospheric, snow, and sea-ice samples to better constrain the spatial and temporal variability of biological nitrogen transformations in the Arctic. Results from this study will provide a first order understanding of the contribution of water masses to the regional nitrogen budget, identify regional nitrogen sources and sinks, and diagnose important biological nitrogen transformations that occur on the Chukchi shelf, and in the central basins.

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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-1435002

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