Dissolved REE concentrations from the US GEOTRACES Arctic cruise (GN01, HLY1502) from August to October 2015

Website: https://www.bco-dmo.org/dataset/835533
Data Type: Cruise Results
Version: 1
Version Date: 2021-01-06

Project
» U.S. Arctic GEOTRACES Study (GN01) (U.S. GEOTRACES Arctic)
» Collaborative Research: GEOTRACES Arctic Section: Nd isotopes and REEs in the Arctic (Arctic GEOTRACES Nd/eNd)

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

Contributors	Affiliation	Role
Goldstein, Steven L.	Lamont-Doherty Earth Observatory (LDEO)	Principal Investigator
Haley, Brian	Oregon State University (OSU)	Co-Principal Investigator
Pena, Leopoldo D.	Lamont-Doherty Earth Observatory (LDEO)	Co-Principal Investigator
Scher, Howard	University of South Carolina	Co-Principal Investigator
Pinedo-Gonzalez, Paulina	Lamont-Doherty Earth Observatory (LDEO)	Analyst
Wu, Yingzhe	Lamont-Doherty Earth Observatory (LDEO)	Analyst
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Dissolved REE concentrations from the US GEOTRACES Arctic cruise (GN01, HLY1502) from August to October 2015. These samples were analyzed at Lamont-Doherty Earth Observatory (LDEO).

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Coverage

Spatial Extent: **N**:89.988 **E**:89.25 **S**:62.202 **W**:-171.585
Temporal Extent: 2015-08-14 - 2015-09-28

Dataset Description

This dataset contains data from samples analyzed at Lamont-Doherty Earth Observatory (LDEO). Additional dissolved REE data are reported by Oregon State University (OSU) in a separate dataset (see 'Related Datasets').

Methods & Sampling

Samples were filtered, acidified, and split at sea. Samples were collected by Niskin bottle. Refer to the cruise report for more information on cruise operations (http://dmoserv3.whoi.edu/data_docs/GEOTRACES/Arctic/ARC01-report.pdf).

For REE concentration analyses, aliquots of 50 mL were taken from each sample. About 12 mL of each sample was then weighed and 30-300 mg of a mixed REE spike enriched in ^{142}Ce, ^{145}Nd, ^{149}Sm, ^{153}Eu, ^{155}Gd, ^{161}Dy, ^{167}Er, and ^{171}Yb was added. Samples were then preconcentrated offline using a SeaFast PICO system (ESI) following the methodology described in Behrens et al., 2016 and Wu et al., 2020. Resulting solutions were analyzed at Lamont Doherty Earth Observatory (Palisades, NY) using a Nu Attom ES HR-ICP-MS.

Data Processing Description

Data Processing:
Dissolved concentrations were determined by a combination of isotope dilution (Ce, Nd, Sm, Eu, Gd, Dy, Er, and Yb) and for La, Lu and the mono-isotopic elements Pr, Tb, Ho, and Tm, their concentrations are calculated by comparing their intensities to intensities of non-spiked isotopes of the elements calculated by isotope dilution. We employed the REE Calculation Workbook published by Wu et al., 2020 to calculate the REE abundances. Precision was determined by repeated analyzes of seawater from a GEOTRACES intercalibration station Bermuda Atlantic Time Series (BATS; 31.7°N, 64.1°W) in the North Atlantic at 20 m and 2,000 m.

Known Problems/Issues:
Gaps in REE concentrations data are due to missing samples, data is flagged with QV:IODE code 9, missing value.

Quality Flags:
Data quality flags have been applied following the IODE scheme, defined as:
1 = good;
2 = not evaluated, not available, or unknown;
3 = questionable/suspect;
4 = bad;
9 = missing data.

BCO-DMO Processing:
- renamed fields;
- replaced "N/A#" with missing data identifier of "nd";
- added ISO8601 date/time fields.

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Data Files

File
REEs_LDEO.csv (Comma Separated Values (.csv), 29.84 KB) MD5:9caf407e89659a51090823876d7e6474 Primary data file for dataset ID 835533

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Related Publications

Behrens, M. K., Muratli, J., Pradoux, C., Wu, Y., Böning, P., Brumsack, H.-J., … Pahnke, K. (2016). Rapid and precise analysis of rare earth elements in small volumes of seawater - Method and intercomparison. Marine Chemistry, 186, 110–120. doi:10.1016/j.marchem.2016.08.006
Methods

Wu, Y., Pena, L. D., Goldstein, S. L., Basak, C., Bolge, L. L., Jones, K. M., … Hemming, S. R. (2020). A User-Friendly Workbook to Facilitate Rapid and Accurate Rare Earth Element Analyses by ICP-MS for Multispiked Samples. Geochemistry, Geophysics, Geosystems, 21(9). doi:10.1029/2020gc009042
https://doi.org/10.1029/2020GC009042
Methods

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Related Datasets

IsRelatedTo

Haley, B., Goldstein, S. L., Scher, H. (2020) **Dissolved REE concentrations and Nd isotopes from the US GEOTRACES Arctic USCGC Healy cruise HLY1502 from August to September 2015.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2020-01-24 doi:10.1575/1912/bco-dmo.788315.1 [view at BCO-DMO]
Relationship Description: Samples were distributed across three different labs. "GN01 Dissolved REEs OSU" contains REE data analyzed at Oregon State University. "GN01 Dissolved REEs LDEO" contains REE data anaylzed at Lamont-Doherty Earth Observatory.

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Parameters

Parameter	Description	Units
Station_ID	Station number	unitless
Start_Date_UTC	Date the event started (UTC); format: DD/MM/YYYY	unitless
Start_Time_UTC	Time the event started (UTC); format: hh:mm	unitless
Start_ISO_DateTime_UTC	Date and time (UTC) at start of event; format: YYYY-MM-DDThh:mmZ	unitless
End_Date_UTC	Date the event ended (UTC); format: DD/MM/YYYY	unitless
End_Time_UTC	Time the event ended (UTC); format: hh:mm	unitless
End_ISO_DateTime_UTC	Date and time (UTC) at end of event; format: YYYY-MM-DDThh:mmZ	unitless
Start_Latitude	Latitude the event started	degrees North
Start_Longitude	Longitude the event started	degrees East
End_Latitude	Latitude the event ended	degrees North
End_Longitude	Longitude the event ended	degrees East
Event_ID	Event number	unitless
Sample_ID	GEOTRACES sample number	unitless
Sample_Depth	Sample depth	meters (m)
Ce_D_CONC_BOTTLE_pedhml	Dissolved Concentration of Cerium (Ce) from bottle samples	picomoles per kilogram (pmol/kg)

SD1_Ce_D_CONC_BOTTLE_pedhml	1-sigma error of dissolved Ce from bottle samples	picomoles per kilogram (pmol/kg)
Flag_Ce_D_CONC_BOTTLE_pedhml	Data quality flag using IODE scheme for Ce_D_CONC_BOTTLE_pedhml	unitless
Sm_D_CONC_BOTTLE_pmlcpz	Dissolved Concentration of Samarium (Sm) from bottle samples	picomoles per kilogram (pmol/kg)
SD1_Sm_D_CONC_BOTTLE_pmlcpz	1-sigma error of dissolved Sm from bottle samples	picomoles per kilogram (pmol/kg)
Flag_Sm_D_CONC_BOTTLE_pmlcpz	Data quality flag using IODE scheme for Sm_D_CONC_BOTTLE_pmlcpz	unitless
Ho_D_CONC_BOTTLE_jrd3wq	Dissolved Concentration of Holmium (Ho) from bottle samples	picomoles per kilogram (pmol/kg)
SD1_Ho_D_CONC_BOTTLE_jrd3wq	1-sigma error of dissolved Ho from bottle samples	picomoles per kilogram (pmol/kg)
Flag_Ho_D_CONC_BOTTLE_jrd3wq	Data quality flag using IODE scheme for Ho_D_CONC_BOTTLE_jrd3wq	unitless
Tb_D_CONC_BOTTLE_zupl71	Dissolved Concentration of Terbium (Tb) from bottle samples	picomoles per kilogram (pmol/kg)
SD1_Tb_D_CONC_BOTTLE_zupl71	1-sigma error of dissolved Tb from bottle samples	picomoles per kilogram (pmol/kg)
Flag_Tb_D_CONC_BOTTLE_zupl71	Data quality flag using IODE scheme for Tb_D_CONC_BOTTLE_zupl71	unitless
Yb_D_CONC_BOTTLE_gt9iau	Dissolved Concentration of Ytterbium (Yb) from bottle samples	picomoles per kilogram (pmol/kg)
SD1_Yb_D_CONC_BOTTLE_gt9iau	1-sigma error of dissolved Yb from bottle samples	picomoles per kilogram (pmol/kg)
Flag_Yb_D_CONC_BOTTLE_gt9iau	Data quality flag using IODE scheme for Yb_D_CONC_BOTTLE_gt9iau	unitless
Pr_D_CONC_BOTTLE_d4ydto	Dissolved Concentration of Praseodymium (Pr) from bottle samples	picomoles per kilogram (pmol/kg)
SD1_Pr_D_CONC_BOTTLE_d4ydto	1-sigma error of dissolved Pr from bottle samples	picomoles per kilogram (pmol/kg)
Flag_Pr_D_CONC_BOTTLE_d4ydto	Data quality flag using IODE scheme for Pr_D_CONC_BOTTLE_d4ydto	unitless
Nd_D_CONC_BOTTLE_bik2po	Dissolved Concentration of Neodymium (Nd) from bottle samples	picomoles per kilogram (pmol/kg)
SD1_Nd_D_CONC_BOTTLE_bik2po	1-sigma error of dissolved Nd from bottle samples	picomoles per kilogram (pmol/kg)
Flag_Nd_D_CONC_BOTTLE_bik2po	Data quality flag using IODE scheme for Nd_D_CONC_BOTTLE_bik2po	unitless
Eu_D_CONC_BOTTLE_zkeses	Dissolved Concentration of Europium (Eu) from bottle samples	picomoles per kilogram (pmol/kg)
SD1_Eu_D_CONC_BOTTLE_zkeses	1-sigma error of dissolved Eu from bottle samples	picomoles per kilogram (pmol/kg)
Flag_Eu_D_CONC_BOTTLE_zkeses	Data quality flag using IODE scheme for Eu_D_CONC_BOTTLE_zkeses	unitless
Lu_D_CONC_BOTTLE_aoadnb	Dissolved Concentration of Lutetium (Lu) from bottle samples	picomoles per kilogram (pmol/kg)
SD1_Lu_D_CONC_BOTTLE_aoadnb	1-sigma error of dissolved Lu from bottle samples	picomoles per kilogram (pmol/kg)

Flag_Lu_D_CONC_BOTTLE_aoadnb	Data quality flag using IODE scheme for Lu_D_CONC_BOTTLE_aoadnb	unitless
La_D_CONC_BOTTLE_8v9ps0	Dissolved Concentration of Lanthanum (La) from bottle samples	picomoles per kilogram (pmol/kg)
SD1_La_D_CONC_BOTTLE_8v9ps0	1-sigma error of dissolved La from bottle samples	picomoles per kilogram (pmol/kg)
Flag_La_D_CONC_BOTTLE_8v9ps0	Data quality flag using IODE scheme for La_D_CONC_BOTTLE_8v9ps0	unitless
Er_D_CONC_BOTTLE_xsrukw	Dissolved Concentration of Erbium (Er) from bottle samples	picomoles per kilogram (pmol/kg)
SD1_Er_D_CONC_BOTTLE_xsrukw	1-sigma error of dissolved Er from bottle samples	picomoles per kilogram (pmol/kg)
Flag_Er_D_CONC_BOTTLE_xsrukw	Data quality flag using IODE scheme for Er_D_CONC_BOTTLE_xsrukw	unitless
Gd_D_CONC_BOTTLE_tregzv	Dissolved Concentration of Gadolinium (Gd) from bottle samples	picomoles per kilogram (pmol/kg)
SD1_Gd_D_CONC_BOTTLE_tregzv	1-sigma error of dissolved Gd from bottle samples	picomoles per kilogram (pmol/kg)
Flag_Gd_D_CONC_BOTTLE_tregzv	Data quality flag using IODE scheme for Gd_D_CONC_BOTTLE_tregzv	unitless
Dy_D_CONC_BOTTLE_sznkhf	Dissolved Concentration of Dysprosium (Dy) from bottle samples	picomoles per kilogram (pmol/kg)
SD1_Dy_D_CONC_BOTTLE_sznkhf	1-sigma error of dissolved Dy from bottle samples	picomoles per kilogram (pmol/kg)
Flag_Dy_D_CONC_BOTTLE_sznkhf	Data quality flag using IODE scheme for Dy_D_CONC_BOTTLE_sznkhf	unitless
Tm_D_CONC_BOTTLE_dbgjvc	Dissolved Concentration of Thulium (Tm) from bottle samples	picomoles per kilogram (pmol/kg)
SD1_Tm_D_CONC_BOTTLE_dbgjvc	1-sigma error of dissolved Tm from bottle samples	picomoles per kilogram (pmol/kg)
Flag_Tm_D_CONC_BOTTLE_dbgjvc	Data quality flag using IODE scheme for Tm_D_CONC_BOTTLE_dbgjvc	unitless

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Instruments

Dataset-specific Instrument Name	High Resolution Inductively Coupled Plasma Mass Spectrometer (HR-ICP-MS)
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	High Resolution Inductively Coupled Plasma Mass Spectrometer (HR-ICP-MS). Attom ES (Nu Instruments). Rare earth element dissolved concentrations were analyzed at Lamont Doherty Earth Observatory using a Nu Attom ES HR-ICP-MS. The HR-ICP-MS is a type of mass spectrometry that uses an inductively couple plasma to ionize a liquid sample. The ions of specific mass-to-charge ratios are then quantified in a mass spectrometer.
Generic Instrument Description	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

Dataset-specific Instrument Name	Niskin
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.

Dataset-specific Instrument Name	SeaFast PICO system (ESI)
Generic Instrument Name	SeaFAST Automated Preconcentration System
Dataset-specific Description	SeaFast Automated Preconcentration System for Undiluted Seawater. Elemental Scientific Inc. (ESI), Omaha, Nebraska, USA. Rare earth element were preconcentrated using a commercially available preconcentration unit that separates the REEs.
Generic Instrument Description	The seaFAST is an automated sample introduction system for analysis of seawater and other high matrix samples for analyses by ICPMS (Inductively Coupled Plasma Mass Spectrometry).

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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 Section: Nd isotopes and REEs in the Arctic (Arctic GEOTRACES Nd/eNd)

Website: http://www.geotraces.org/

Coverage: Arctic Ocean

NSF Award Abstract:
In this project, investigators participating in the 2015 U.S. GEOTRACES Arctic expedition will measure neodymium isotopes and rare earth elements in seawater, sediment, and particulates collected from the western Arctic Ocean. In common with other national 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. Neodymium and rare earth elements are oceanographic tracers, and data from this research will provide benchmarks for other trace element and isotope studies to better understand their cycles and how future environmental changes will impact this important ocean basin. The project will support the training of undergraduate, graduate, and post-doctoral researchers, and results will be disseminated via public outreach activities.

Neodymium (Nd) isotopes are tracers of water mass sources, transport and mixing, and rare earth elements (REEs) show systematic fractionations during environmental processes. Together they provide a powerful tool for analyzing provenances and processes in the oceans that reflect the changing environmental controls on the distribution of trace elements and their isotopes (TEIs). Inherent logistical difficulties make the Arctic Ocean especially scarce in TEI data (including Nd isotopes and REE concentrations), which hinders understanding and application of these tracers. In this study, researchers will examine Nd and REE concentrations in seawater, sediment, and particulate samples collected in the western Arctic Ocean, with the aim of (1) assessing Arctic circulation and water mass mixing in light of Nd isotopes and REEs; (2) attempting to quantify particle-dissolved exchanges of TEIs and; (3) using Nd isotopes and REEs to characterize the sources, sinks and exchanges of TEIs. It is expected that through improved understanding of the Nd isotope and REEs tracers, scientists will be able to relate these findings to other TEIs and to the broader understanding of Arctic oceanographic change in the past, present, and future.

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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-1459513
NSF Division of Ocean Sciences (NSF OCE)	OCE-1458936
NSF Division of Ocean Sciences (NSF OCE)	OCE-1459716

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