Dissolved REE concentrations and Nd isotopes from the US GEOTRACES Arctic USCGC Healy cruise HLY1502 from August to September 2015

Website: https://www.bco-dmo.org/dataset/788315
Data Type: Cruise Results
Version: 1
Version Date: 2020-01-24

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
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Abstract
Dissolved REE concentrations and Nd isotopes from the US GEOTRACES Arctic USCGC Healy cruise HLY1502 from August to September 2015. These samples were analyzed at Oregon State University (OSU).

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Coverage

Spatial Extent: **N**:87.8259 **E**:179.1997 **S**:79.9835 **W**:-179.8086
Temporal Extent: 2015-08-23 - 2015-09-16

Dataset Description

This dataset contains data from samples analyzed at Oregon State University (OSU). Additional dissolved REE data are reported by Lamont-Doherty Earth Observatory (LDEO) 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 concentrations we removed an aliquot before pH-adjustment of each sample. Sample methodology is modified from the Lab #3 methods in Behrens et al. (2006) using a technique pioneered by Tachikawa et al. (1999). Samples were spiked with a mixed 142Ce, 148Nd, and 176Yb enriched isotope spike blend, and 10 ml of this spiked sample was preconcentrated offline using a SeaFast PICO system (ESI). Resulting solutions were analysed at Oregon State University (Corvallis, OR) using a Thermo X-Series II ICP-MS.

We prepared our 5L split for neodymium isotopic analysis following Shabani et al. (1992). Samples were pH-adjusted to pH ~3.5, then pumped through 300 µl of HDEHP in a C18 cartridge to capture REEs. Rare earth elements were eluted from the cartridge using 6M HCl, then Nd was isolated using sequential chromatographic columns: AG50-X8 (BioRad) and Ln-Spec (Eichrom). Neodymium isotopic measurements were made at Oregon State University using a Nu Plasma 3 multicollector ICP-MS (Nu Instruments).

Problem report: Gaps in Nd isotope data are due to errors made during column chromatography. Where the 2-sigma error of epsilon-Nd is ≥0.7, data is flagged with QV:IODE code 3, questionable/suspect quality.

Data Processing Description

Neodymium isotope ratios were corrected using JNdi-1 standard for reference (Tanaka et al., 2000). Dissolved concentrations were determined by a combination of isotope dilution and external calibration following methods developed by Tachikawa et al. (1999) and used by Lacan and Jeandel (2001) and Jeandel et al. (2013). Calibration standards were diluted and spiked with a mixed 142Ce, 148Nd, and 176Yb enriched isotope spike blend and were pre-concentrated using the same method as the samples. For Ce the concentration was determined by isotope dilution using 142Ce. For the other REEs we determined the concentrations of Nd and Yb in the samples both by isotope dilution and by external calibration, then used these two results to generate a ratio (spiked value / external calibration value) that we applied to the other REEs. Precision was determined by repeated measurements of two in-house seawater samples, one from Bransfeld Strait (~1100m depth) and one from nearshore California (~surface depth). Reported values here of Ce, Nd, and Yb are calculated by isotope dilution, and for other REEs by external calibration modified by the ratio described above.

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Data Files

File
REEs.csv (Comma Separated Values (.csv), 21.52 KB) MD5:cef02ffcd55793f4e9d25c7f34502ce9 Primary data file for dataset ID 788315

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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

Jeandel, C., Delattre, H., Grenier, M., Pradoux, C., & Lacan, F. (2013). Rare earth element concentrations and Nd isotopes in the Southeast Pacific Ocean. Geochemistry, Geophysics, Geosystems, 14(2), 328–341. doi:10.1029/2012gc004309 https://doi.org/10.1029/2012GC004309
Methods

Lacan, F., & Jeandel, C. (2001). Tracing Papua New Guinea imprint on the central Equatorial Pacific Ocean using neodymium isotopic compositions and Rare Earth Element patterns. Earth and Planetary Science Letters,

186(3-4), 497–512. doi:10.1016/s0012-821x(01)00263-1 https://doi.org/10.1016/S0012-821X(01)00263-1
Methods

Shabani, M. B., Akagi, T., & Masuda, A. (1992). Preconcentration of trace rare-earth elements in seawater by complexation with bis(2-ethylhexyl) hydrogen phosphate and 2-ethylhexyl dihydrogen phosphate adsorbed on a C18 cartridge and determination by inductively coupled plasma mass spectrometry. Analytical Chemistry, 64(7), 737–743. doi:10.1021/ac00031a008
Methods

Tachikawa, K., Jeandel, C., & Roy-Barman, M. (1999). A new approach to the Nd residence time in the ocean: the role of atmospheric inputs. Earth and Planetary Science Letters, 170(4), 433–446. doi:10.1016/s0012-821x(99)00127-2 https://doi.org/10.1016/S0012-821X(99)00127-2
Methods

Tanaka, T., Togashi, S., Kamioka, H., Amakawa, H., Kagami, H., Hamamoto, T., … Dragusanu, C. (2000). JNdi-1: a neodymium isotopic reference in consistency with LaJolla neodymium. Chemical Geology, 168(3-4), 279–281. doi:10.1016/s0009-2541(00)00198-4 https://doi.org/10.1016/S0009-2541(00)00198-4
Methods

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Related Datasets

IsRelatedTo

Goldstein, S. L., Pinedo-Gonzalez, P., Wu, Y. (2021) **Dissolved REE concentrations from the US GEOTRACES Arctic cruise (GN01, HLY1502) from August to October 2015.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-01-06 doi:10.26008/1912/bco-dmo.835533.1 [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
Cruise	Cruise identification (GN01; HLY1502)	unitless
STNNBR	Station number	unitless
GEOTRC_SAMPNO	Unique GEOTRACES sample number	unitless
CTDDEPTH	Sample depth	meters (m)
DATE	Date; format: yyyymmdd	unitless
TIME	Time (UTC); format: HHMM	unitless
LATITUDE	Latitude	degrees North
LONGITUDE	Longitude; negative = West	degrees East
La_D_CONC_BOTTLE	Dissolved Concentration of Lanthanum (La) from bottle samples	picomoles per kilogram (pmol/kg)
La_D_CONC_BOTTLE_QV_IODE	La_D_CONC_BOTTLE data quality flag using IODE scheme	unitless
Ce_D_CONC_BOTTLE	Dissolved Concentration of Cerium (Ce) from bottle samples	pmol/kg
Ce_D_CONC_BOTTLE_QV_IODE	Ce_D_CONC_BOTTLE data quality flag using IODE scheme	unitless

Pr_D_CONC_BOTTLE	Dissolved Concentration of Praseodymium (Pr) from bottle samples	pmol/kg
Pr_D_CONC_BOTTLE_QV_IODE	Pr_D_CONC_BOTTLE data quality flag using IODE scheme	unitless
Nd_D_CONC_BOTTLE	Dissolved Concentration of Neodymium (Nd) from bottle samples	pmol/kg
Nd_D_CONC_BOTTLE_QV_IODE	Nd_D_CONC_BOTTLE data quality flag using IODE scheme	unitless
Sm_D_CONC_BOTTLE	Dissolved Concentration of Samarium (Sm) from bottle samples	pmol/kg
Sm_D_CONC_BOTTLE_QV_IODE	Sm_D_CONC_BOTTLE data quality flag using IODE scheme	unitless
Eu_D_CONC_BOTTLE	Dissolved Concentration of Europium (Eu) from bottle samples	pmol/kg
Eu_D_CONC_BOTTLE_QV_IODE	Eu_D_CONC_BOTTLE data quality flag using IODE scheme	unitless
Gd_D_CONC_BOTTLE	Dissolved Concentration of Gadolinium (Gd) from bottle samples	pmol/kg
Gd_D_CONC_BOTTLE_QV_IODE	Gd_D_CONC_BOTTLE data quality flag using IODE scheme	unitless
Tb_D_CONC_BOTTLE	Dissolved Concentration of Terbium (Tb) from bottle samples	pmol/kg
Tb_D_CONC_BOTTLE_QV_IODE	Tb_D_CONC_BOTTLE data quality flag using IODE scheme	unitless
Dy_D_CONC_BOTTLE	Dissolved Concentration of Dysprosium (Dy) from bottle samples	pmol/kg
Dy_D_CONC_BOTTLE_QV_IODE	Dy_D_CONC_BOTTLE data quality flag using IODE scheme	unitless
Ho_D_CONC_BOTTLE	Dissolved Concentration of Holmium (Ho) from bottle samples	pmol/kg
Ho_D_CONC_BOTTLE_QV_IODE	Ho_D_CONC_BOTTLE data quality flag using IODE scheme	unitless
Er_D_CONC_BOTTLE	Dissolved Concentration of Erbium (Er) from bottle samples	pmol/kg
Er_D_CONC_BOTTLE_QV_IODE	Er_D_CONC_BOTTLE data quality flag using IODE scheme	unitless
Tm_D_CONC_BOTTLE	Dissolved Concentration of Thulium (Tm) from bottle samples	pmol/kg
Tm_D_CONC_BOTTLE_QV_IODE	Tm_D_CONC_BOTTLE data quality flag using IODE scheme	unitless
Yb_D_CONC_BOTTLE	Dissolved Concentration of Ytterbium (Yb) from bottle samples	pmol/kg
Yb_D_CONC_BOTTLE_QV_IODE	Yb_D_CONC_BOTTLE data quality flag using IODE scheme	unitless
Lu_D_CONC_BOTTLE	Dissolved Concentration of Lutetium (Lu) from bottle samples	pmol/kg
Lu_D_CONC_BOTTLE_QV_IODE	Lu_D_CONC_BOTTLE data quality flag using IODE scheme	unitless
Nd_143_144_D_EPSILON_BOTTLE	Isotopic ratio of neodymium 143/144 from bottle samples	epsilon units

Nd_143_144_D_EPSILON_BOTTLE_SD	1-sigma error of Epsilon Nd from bottle samples	epsilon units
Nd_143_144_D_EPSILON_BOTTLE_QV_IODE	Nd_143_144_D_EPSILON_BOTTLE data quality flag using IODE scheme	unitless
ISO_DateTime_UTC	Date and time (UTC) formatted to ISO8601 standard: yyyy-mm-ddTHH:MM	unitless

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Instruments

Dataset-specific Instrument Name	Nu Plasma 3 multi-collector ICP-MS
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Neodymium isotopic measurements were made at Oregon State University using a Nu Plasma 3 multi-collector ICP-MS.
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	Thermo X-Series II ICP-MS
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Rare earth element dissolved concentrations were analysed at Oregon State University using a Thermo X-Series II ICP-MS.
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	
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

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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