# 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 |
|---|---|---|
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| Pena, Leopoldo D. | Lamont-Doherty Earth Observatory (LDEO) | Co-Principal Investigator |
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**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

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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) |

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|---|---|---|
| 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) |

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|---|---|---|
| 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) |

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|---|---|---|
| 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.

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