Neodymium (Nd) isotopes measured from dissolved seawater on Leg 2 (Hilo, HI to Papeete, French Polynesia) of the US GEOTRACES Pacific Meridional Transect (PMT) cruise (GP15, RR1815) on R/V Roger Revelle from October to November 2018

Website: https://www.bco-dmo.org/dataset/929950
Data Type: Cruise Results
Version: 1
Version Date: 2025-07-09

Project
» US GEOTRACES Pacific Meridional Transect (GP15) (U.S. GEOTRACES PMT)
» Collaborative Research: US GEOTRACES Pacific Meridional Transect: Sources and Sinks of Neodymium Isotopes and Rare Earth Elements (GP15 Nd isotopes)

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

Contributors	Affiliation	Role
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Abstract
The goal of the international GEOTRACES program is to understand the distributions of trace chemical elements and their isotopes in the oceans. Neodymium (Nd) isotopes are widely recognized for their utility as tracers of water transport and as indicators of the sources of trace elements to the oceans. Neodymium isotopes have been designated as "key parameters" to be measured on GEOTRACES expeditions. The data here represent Nd isotopes measured from dissolved seawater on the GP15 GEOTRACES expedition in the Pacific Ocean. The North Pacific is a particularly interesting place to measure Nd isotopes because North Pacific and North Atlantic deep waters represent the two end-members of deep ocean composition, and the few data available so far in the North Pacific differ from expectations based on mixing of known water types. These data are dissolved Nd isotopes measured in profiles at stations on the second leg of the cruise, RR1815.

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Coverage

Location: Pacific Ocean, Tahiti to Alaska, along the 150°W meridian
Spatial Extent: **N**:11 **E**:-152 **S**:-5 **W**:-152.019
Temporal Extent: 2018-10-30 - 2018-11-14

Methods & Sampling

Sampling methods at sea followed the GEOTRACES cookbook (Cutter et al., 2017). Water samples were collected in 10-liter Niskin bottles with nylon-coated closure springs and Viton O-rings. The seawater collected was filtered with Pall Acropak 500 filters (0.8- and 0.45-micrometer (µm) pore size) into LDPE cubitainers. Shallow casts of the ODF rosette collected single 10-liter samples for Th isotopes, 231Pa, and Nd isotopes. Otherwise, 4 to 5 liters were collected for each sample. After filtering, samples were adjusted to a pH of ~2 with 20 milliliters (mL) 6 M HCl (redistilled Fisher Scientific Trace Metal grade HCl). Samples were stored and shipped to labs double-bagged at ambient temperatures.

All Neodymium (Nd) isotope samples were preconcentrated using C18cartridges (Waters Corp., Sep-Pak classic, 360 mg, 55-105 µm) loaded with complexing agent of 2-ethylhexyl hydrogen phosphate (HDEHP) and 2-ethylhexyl dihydrogen phosphate (H2MEHP) mixture (Sigma Aldrich), following Pahnke etal., 2012. Specifically, C18 cartridges were first cleaned in a 0.5 N HCl bath overnight, passed through 10 mL of 6 N HCl and then flushed with >500 mL of Milli-Q water. Prior to sample introduction, 300 µL of complexing agent HDEHP/H2MEHP was loaded on a clean cartridge. Seawater samples were adjusted to pH ≈ 3.5 by adding Optima® ammonium hydroxide, then were pumped through the cartridges at 20 mL per minute by a peristaltic pump. Cartridges were first eluted with 10 mL of 0.01 N HCl to remove barium. The cartridges were then eluted with 35 mL of 6 N HCl at 10 mL per minute by a peristaltic pump to collect rare earth elements (REEs). REEs were dried and further purified using column chemistry (Biorad® AG-50 followed by Eichrom® Ln-Spec) to separate Nd from the other REEs (Pahnke etal., 2012). All Nd isotopes were measured at Oregon State University (OSU) with a Nu3 multicollector-inductively coupled plasma-mass spectrometer (MC-ICP-MS). The instrument was coupled with an Apex-2 desolvating nebulizer. All measured Nd isotopic compositions were corrected for mass fractionation using an exponential law with 146Nd/144Nd = 0.7219. The standard JNdi-1 was measured between every sample as sample-standard bracketing. JNdi-1 standards of 50 parts per billion (ppb), yielded internal reproducibility (2σ) of ±0.30 εNd units. External reproducibility was determined by multiple (n= 55) runs of an in-house Specpure Nd standard (2σ error = 0.5 εNd units). The total procedural blank was measured by quadrupole ICP-MS at ~3.5 picomoles (pM) Nd. Our Limit Of Detection (LOD) for Nd isotopic analyses on the Nu3 was set to <2 V total Nd; generally equivalent to a solution of ~3 ppb Nd, or 3 nanograms (ng) Nd. This LOD is somewhat arbitrary, but was established in light of unacceptable error on the 143Nd/144Nd ratios produced below this level.

Data Processing Description

Data were flagged using the SeaDataNet quality flag scheme. For more information on SeaDataNet flags, see: https://www.geotraces.org/geotraces-quality-flag-policy/ and https://www.seadatanet.org/Standards/Data-Quality-Control

SeaDataNet quality flag definitions:
0 = No quality control;
1 = Good value;
2 = Probably good value;
3 = Probably bad value;
4 = Bad value;
5 = Changed value;
6 = Value below detection;
7 = Value in excess;
8 = Interpolated value;
9 = Missing value;
A = Value phenomenon uncertain.

BCO-DMO Curation Notes

- Imported original file "BH1_RR1815_BCO-DMO_eNd.xlsx" into the BCO-DMO system.
- Removed rows for station 18.3, which were moved to the Leg 1 dataset.
- Renamed fields to comply with BCO-DMO naming conventions.
- Created date-time field in ISO 8601 format.
- Converted date fields to YYYY-MM-DD format.
- Removed empty columns: Gear_ID, End_Latitude, End_Longitude, Rosette_Position.
- Updated quality flag column, "Flag_Nd_143_144_D_EPSILON_BOTTLE_x2epvg", as instructed by dataset PI, replacing strings with the appropriate integer.
- Saved final file as "929950_v1_gp15_nd_isotopes_leg2.csv".
- This dataset has been published "as is". Final review by the data submitter was not received after the data were imported into the BCO-DMO data system.

Problem Description

Many samples were of insufficient Nd for accurate analyses (most in the upper water column, where neodymium concentrations are very low).

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Data Files

File
929950_v1_gp15_nd_isotopes_leg2.csv (Comma Separated Values (.csv), 4.79 KB) MD5:52373e154d36ea550da2161f62f5e9e4 Primary data file for dataset ID 929950, version 1

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Related Publications

Cutter, Gregory, Casciotti, Karen, Croot, Peter, Geibert, Walter, Heimbürger, Lars-Eric, Lohan, Maeve, Planquette, Hélène, van de Flierdt, Tina (2017) Sampling and Sample-handling Protocols for GEOTRACES Cruises (Cookbook). Version 3, August 2017. Toulouse, France, GEOTRACES International Project Office, 139pp. & Appendices. http://hdl.handle.net/11329/409
Methods

Pahnke, K., van de Flierdt, T., Jones, K. M., Lambelet, M., Hemming, S. R., & Goldstein, S. L. (2012). GEOTRACES intercalibration of neodymium isotopes and rare earth element concentrations in seawater and suspended particles. Part 2: Systematic tests and baseline profiles. Limnology and Oceanography: Methods, 10(4), 252–269. doi:10.4319/lom.2012.10.252
Methods

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Related Datasets

Continues

Haley, B., Muratli, J. (2025) **Neodymium (Nd) isotopes measured from dissolved seawater on Leg 1 (Seattle, WA to Hilo, HI) of the US GEOTRACES Pacific Meridional Transect (PMT) cruise (GP15, RR1814) on R/V Roger Revelle from September to October 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-07-09 doi:10.26008/1912/bco-dmo.929937.1 [view at BCO-DMO]
Relationship Description: GP15 was made up of two cruise legs, RR1814 (Leg 1) and RR1815 (Leg 2).

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Parameters

Parameter	Description	Units
Station_ID	GP15 station number	unitless
Event_ID	GP15 event number	unitless
Start_Date_UTC	Start date (UTC)	unitless
Start_Time_UTC	Start time (UTC)	unitless
Start_ISO_DateTime_UTC	Start date and time (UTC) in ISO 8601 format	unitless
End_Date_UTC	End date (UTC)	unitless
End_Time_UTC	End time (UTC)	unitless
End_ISO_DateTime_UTC	End date and time (UTC) in ISO 8601 format	unitless
Start_Latitude	Start latitude; positive values = North	decimal degrees
Start_Longitude	Start longitude; negative values = West	decimal degrees
Sample_ID	GEOTRACES sample number	unitless
Sample_Depth	Water depth of sampling	meters (m)
Nd_143_144_D_EPSILON_BOTTLE_x2epvg	Ratio of 143Nd to 144Nd, given in epsilon unit notation: the 143Nd/144Nd of the sample relavtive to a bulk earth reference (CHUR) in parts per 10,000	epsilon notation (parts per 10,000)
SD1_Nd_143_144_D_EPSILON_BOTTLE_x2epvg	One sigma standard deviation of external error of analyses, as given by long-term analyses of in-house standard (n = 55)	epsilon notation (parts per 10,000)
Flag_Nd_143_144_D_EPSILON_BOTTLE_x2epvg	Quality flag	unitless

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Instruments

Dataset-specific Instrument Name	Nu3 multicollector-inductively coupled plasma-mass spectrometer (MC-ICP-MS)
Generic Instrument Name	Multi Collector Inductively Coupled Plasma Mass Spectrometer
Generic Instrument Description	A Multi Collector Inductively Coupled Plasma Mass Spectrometry (MC-ICPMS) is a type of mass spectrometry where the sample is ionized in a plasma (a partially ionized gas, such as Argon, containing free electrons) that has been generated by electromagnetic induction. A series of collectors is used to detect several ion beams simultaneously. A MC-ICPMS is a hybrid mass spectrometer that combines the advantages of an inductively coupled plasma source and the precise measurements of a magnetic sector multicollector mass spectrometer. The primary advantage of the MC-ICPMS is its ability to analyze a broader range of elements, including those with high ionization potential that are difficult to analyze by Thermal Ionization Mass Spectrometry (TIMS). The ICP source also allows flexibility in how samples are introduced to the mass spectrometer and allows the analysis of samples introduced either as an aspirated solution or as an aerosol produced by laser ablation.

Dataset-specific Instrument Name	10-liter Niskin bottles
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

RR1815

Website	https://www.bco-dmo.org/deployment/776917
Platform	R/V Roger Revelle
Report	https://datadocs.bco-dmo.org/docs/geotraces/GEOTRACES_PMT/casciotti/data_docs/GP15_Cruise_Report_with_ODF_Report.pdf
Start Date	2018-10-24
End Date	2018-11-24
Description	Additional cruise information is available from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/RR1815

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Project Information

US GEOTRACES Pacific Meridional Transect (GP15) (U.S. GEOTRACES PMT)

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

Coverage: Pacific Meridional Transect along 152W (GP15)

A 60-day research cruise took place in 2018 along a transect from Alaska to Tahiti at 152° W. A description of the project titled "*Collaborative Research: Management and implementation of the US GEOTRACES Pacific Meridional Transect*", funded by NSF, is below. Further project information is available on the US GEOTRACES website and on the cruise blog. A detailed cruise report is also available as a PDF.

Description from NSF award abstract:
GEOTRACES is a global effort in the field of Chemical Oceanography in which the United States plays a major role. The goal of the GEOTRACES program is to understand the distributions of many elements and their isotopes in the ocean. Until quite recently, these elements could not be measured at a global scale. Understanding the distributions of these elements and isotopes will increase the understanding of processes that shape their distributions and also the processes that depend on these elements. For example, many "trace elements" (elements that are present in very low amounts) are also important for life, and their presence or absence can play a vital role in the population of marine ecosystems. This project will launch the next major U.S. GEOTRACES expedition in the Pacific Ocean between Alaska and Tahiti. The award made here would support all of the major infrastructure for this expedition, including the research vessel, the sampling equipment, and some of the core oceanographic measurements. This project will also support the personnel needed to lead the expedition and collect the samples.

This project would support the essential sampling operations and infrastructure for the U.S. GEOTRACES Pacific Meridional Transect along 152° W to support a large variety of individual science projects on trace element and isotope (TEI) biogeochemistry that will follow. Thus, the major objectives of this management proposal are: (1) plan and coordinate a 60 day research cruise in 2018; (2) obtain representative samples for a wide variety of TEIs using a conventional CTD/rosette, GEOTRACES Trace Element Sampling Systems, and in situ pumps; (3) acquire conventional CTD hydrographic data along with discrete samples for salinity, dissolved oxygen, algal pigments, and dissolved nutrients at micro- and nanomolar levels; (4) ensure that proper QA/QC protocols are followed and reported, as well as fulfilling all GEOTRACES intercalibration protocols; (5) prepare and deliver all hydrographic data to the GEOTRACES Data Assembly Centre (via the US BCO-DMO data center); and (6) coordinate all cruise communications between investigators, including preparation of a hydrographic report/publication. This project would also provide baseline measurements of TEIs in the Clarion-Clipperton fracture zone (~7.5°N-17°N, ~155°W-115°W) where large-scale deep sea mining is planned. Environmental impact assessments are underway in partnership with the mining industry, but the effect of mining activities on TEIs in the water column is one that could be uniquely assessed by the GEOTRACES community. In support of efforts to communicate the science to a wide audience the investigators will recruit an early career freelance science journalist with interests in marine science and oceanography to participate on the cruise and do public outreach, photography and/or videography, and social media from the ship, as well as to submit articles about the research to national media. The project would also support several graduate students.

Collaborative Research: US GEOTRACES Pacific Meridional Transect: Sources and Sinks of Neodymium Isotopes and Rare Earth Elements (GP15 Nd isotopes)

Coverage: North Pacific

NSF Award Abstract:
The goal of the international GEOTRACES program is to understand the distributions of trace chemical elements and their isotopes in the oceans. Neodymium (Nd) isotopes and rare earth elements (REE) are widely recognized for their utility as tracers of water transport and as indicators of the sources of trace elements to the oceans. Neodymium isotopes have been designated as "key parameters" to be measured on GEOTRACES expeditions. This project would measure Nd isotopes on a 2018 GEOTRACES expedition in the Pacific Ocean. The North Pacific is a particularly interesting place to measure Nd isotopes because North Pacific and North Atlantic deep waters represent the two end-members of deep ocean composition, and the few data available so far in the North Pacific differ from expectations based on mixing of known water types.

The US GEOTRACES Pacific Meridional Transect (PMT) from Tahiti to Alaska will play an important role in solving the "mystery" of North Pacific neodymium isotope ratios. The PMT is designed to extensively sample the oldest waters in the ocean, along with Alaskan coastal margins, volcanogenic sediments, the meridional dust gradient originating from volcanic arcs and the Asian and North American continents, and large gradients in biological productivity. The primary purpose of this project is to characterize the Nd isotope ratio of seawater along the transect. In order to address fundamental questions on the Nd and REE cycle in the Pacific, the investigators will also quantify boundary exchange effects, atmospheric inputs, provenance of particles, impacts of biological productivity, and fluxes into and out of seawater, in order to assess Nd and REE sources and sinks, and to calibrate Nd isotopes as a paleocirculation proxy in the Pacific. Specific focus areas include: (1) Nd isotopic characterization of the shallow and deep waters, (2) margin processes associated with the Alaska volcanic arc shelf, to study chemical exchanges between particulates, sediments, and seawater Nd isotopes and REE, (3) changing meridional dust sources and its impacts, (4) relationships between bottom sediment types, compositions, nepheloid layers, and their influence on the water column, (5) the effects of pore water flow on the water column; (6) the signal transfer between the deep water and sedimentary archives (e.g., fossil fish teeth, Fe-Mn oxide coatings). The project will advance the career of a postdoctoral research

scientist, and support numerous undergraduate students.

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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-1737394

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