

Total dissolved, dissolved labile, and soluble nickel concentrations determined in water column samples collected on the 2019 Bermuda Atlantic Iron Time-series (BAIT) cruises in the Western Subtropical North Atlantic Gyre

Website: <https://www.bco-dmo.org/dataset/940164>

Data Type: Cruise Results

Version: 1

Version Date: 2024-10-11

Project

» [NSFGEO-NERC: Collaborative Research: Using Time-series Field Observations to Constrain an Ocean Iron Model](#) (BAIT)

Program

» [U.S. GEOTRACES](#) (U.S. GEOTRACES)

Contributors	Affiliation	Role
Buck, Kristen Nicolle	University of South Florida (USF)	Principal Investigator
Sedwick, Peter N.	Old Dominion University (ODU)	Principal Investigator
Caprara, Salvatore	University of South Florida (USF)	Scientist
Parente, Caitlyn Elizabeth	University of South Florida (USF)	Student
Sohst, Bettina	Old Dominion University (ODU)	Technician
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract

This dataset includes the total dissolved, dissolved labile, and soluble nickel concentration results determined in water column samples collected using a trace-metal clean CTD rosette, or an inflatable dinghy, during four cruises in the Bermuda Atlantic Time-series Study (BATS) region in March, May, August, and November 2019. The samples and associated data were collected for the Bermuda Atlantic Iron Time-series (BAIT) project (GEOTRACES Process Study GApr13). Post-cruise sample analyses were performed at the University of South Florida (labile dissolved nickel) and Old Dominion University (dissolved nickel, soluble nickel).

Table of Contents

- [Coverage](#)
- [Dataset Description](#)
 - [Methods & Sampling](#)
 - [Data Processing Description](#)
 - [BCO-DMO Processing Description](#)
 - [Problem Description](#)
- [Data Files](#)
- [Related Publications](#)
- [Parameters](#)
- [Instruments](#)
- [Deployments](#)
- [Project Information](#)
- [Program Information](#)
- [Funding](#)

Coverage

Spatial Extent: N:32.151 E:-63.58 S:31.177 W:-64.815

Temporal Extent: 2019-03-11 - 2019-11-21

Methods & Sampling

Sample Collection:

Trace metal clean techniques were employed to collect seawater samples from the BATS site (31°40'N, 64°10'W) in 2019 on 12 March, 14 May, 19 August, and 19 November aboard the R/V Endeavor (March) and R/V Atlantic Explorer (May-November). A trace metal clean carousel (SeaBird Electronics) with a conductivity-temperature-depth sensor (SBE 19 plus, SeaBird Electronics) was fitted with custom-modified 5-liter (L) Teflon-lined external-closure Niskin-X samplers (General Oceanics) and deployed on an Amsteel non-metallic line for the collection of hydrographic data and water column samples from twelve depths (Sedwick et al. 2023). In August, an additional surface (0.3 meter (m)) sample was collected ~500 m upwind of the ship by deploying a Niskin-X sampler from an inflatable dinghy. All seawater samples collected for dissolved nickel analyses were filtered (0.2-micrometer (μm)) (AcroPak, Pall) into acid-cleaned low-density polyethylene (LDPE; Nalgene) bottles, acidified to pH 1.7 (0.024 molar (M) Q-HCl, Fisher Optima) by addition of 6 M ultrapure hydrochloric acid (Fisher Optima), and stored double bagged in buckets at room temperature. For soluble ($<0.02 \mu\text{m}$) nickel analyses, 0.2 μm -filtered seawater was passed through a Milli-Q ($\geq 18.2 \text{ M}\Omega \text{ cm}$) and sample-rinsed 0.02 μm Anotop syringe filter (Sigma-Aldrich) using a peristaltic pump and collected in acid-cleaned LDPE bottles (Ussher et al. 2010); soluble nickel samples were also acidified to pH 1.7 and stored at room temperature. Seawater samples collected for dissolved nickel speciation analyses were 0.2 μm -filtered into acid-cleaned and Milli-Q conditioned fluorinated high-density polyethylene (FPE; Nalgene) bottles and stored at -20 degrees Celsius ($^{\circ}\text{C}$) until analysis.

Total Dissolved and Soluble Ni Concentrations:

Concentrations of total dissolved and soluble nickel (Ni) were determined in the acidified seawater filtrates using inductively-coupled plasma mass spectrometry (ICP-MS, Thermo Fisher Scientific ElementXR), with in-line separation-preconcentration (Elemental Scientific SeaFAST SP3) modified after Lagerström et al. (2013). Calibration standards were prepared in low-analyte concentration filtered seawater for which initial concentrations were determined using the method of standard additions. Calibration standards were introduced using the same in-line separation-preconcentration procedure as the seawater filtrate samples, with yttrium was used as an internal standard for all samples except where indicated. Analytical blank concentrations were assessed by applying the in-line separation-preconcentration procedure including all reagents and loading air in place of the seawater filtrate sample ("air blank").

Labile Dissolved Ni:

A stock solution of dimethylglyoxime (DMG; Acros Organics, 99+%) was made in methanol (Optima, Fisher) to a concentration of 0.1 M (Saito and Moffett 2001). A working solution of DMG was prepared by diluting the 0.1 M stock with methanol to a concentration of 0.01 M. A 1.5 M borate-ammonium buffer (Ellwood and Van den Berg 2000) was prepared by dissolving 18.55 grams (g) boric acid (Aldrich, 99.999% trace metals basis) in 200 milliliters (mL) 0.4 N ammonium hydroxide (Optima, Fisher). The borate-ammonium buffer was purified of trace metal contaminants by passing through two consecutive chromatography columns containing cleaned and preconditioned Chelex® 100 resin (100-200 mesh, Bio-Rad Laboratories) at a speed of 2 milliliters per minute (mL min⁻¹) (Mellett and Buck 2020). Ni and copper (Cu) standards at various concentrations were prepared from 1000-fold dilutions of atomic absorption standards in 0.024 M HCl (Optima, Fisher).

Labile dissolved Ni (DNi) concentrations were measured in seawater samples using competitive ligand exchange-adsorptive cathodic stripping voltammetry (CLE-AdCSV) with DMG as the added competitive ligand (van den Berg and Nimmo 1987, Saito et al. 2004, Boiteau et al. 2016). Seawater samples were thawed in the refrigerator overnight and then allowed to reach room temperature before 10 mL aliquots were dispensed into acid-cleaned Teflon vials (Savillex) and amended with 7.5 millimolar (mM) borate-ammonium buffer (pH=8.2, NBS scale, Ellwood and Van den Berg 2000) and 200 micromolar (μM) DMG (Boiteau et al. 2016). Samples were then allowed to equilibrate for at least 12 hours prior to analysis (Boiteau et al. 2016) and analyzed within 24 hours of the DMG addition (van den Berg and Nimmo 1987). Previous work indicated that some natural ligands preferentially bind Cu over Ni (Boiteau et al. 2016). To investigate the specificity of Ni-binding ligands in this study, a duplicate of each seawater sample was equilibrated with Cu prior to the DMG addition. For these Cu replicates, 10 mL seawater sample aliquots were amended with 7.5 mM borate-ammonium buffer and 10 nanomolar (nM) Cu and allowed to equilibrate for 12 hours. After the Cu equilibration period, DMG was added to a concentration of 200 μM , and samples were allowed to equilibrate for an additional 12 hours before analysis.

A BioAnalytical Systems (BASi) controlled growth hanging mercury drop electrode (CGME) was interfaced with an Epsilon 2 (BASi) analyzer for measurement of labile DNi concentrations. At the time of analysis, samples were purged for 5 minutes with high-purity nitrogen gas (N₂) to minimize oxygen interference. For each run, a 30-second deposition time at -0.7 volts (V) was followed by a 10-second quiet time, and a linear sweep from -0.7 V to -1.4 V with a scan rate of 10 volts per second (V s⁻¹) was performed (Dupont et al. 2010). A drop size of ten was used with a stirrer speed of 600 rpm. Samples were measured for ambient labile DNi at least three times before Ni standard additions. For each standard addition, 0.5 nM or 1 nM Ni was dispensed into the electrochemical cell, which was subsequently purged for another 30 seconds before the sample was measured.

again in at least triplicate. Ni additions continued until the resulting peak heights were double those produced by the natural sample.

Data Processing Description

Voltammograms were imported to ElectroChemistry Data SOFTware (ECDSoft) for baseline subtraction and measurement of peak heights (Omanovic and Branica 1998). The concentration of labile dissolved Ni in each sample was determined by dividing triplicate initial peak heights by the slope found from linear regression of the dissolved nickel additions and averaging the results of all measurements.

Quality Flags:

Data were flagged using the SeaDataNet quality flag scheme recommended by GEOTRACES (<https://www.geotraces.org/geotraces-quality-flag-policy/>) and described below. Notes specific to the application of these flags to this dataset are noted in brackets [...].

- 1: Good Value: Good quality data value that is not part of any identified malfunction and has been verified as consistent with real phenomena during the quality control process. [Used for samples with replicate measurements].
- 2: Probably Good Value: Data value that is probably consistent with real phenomena, but this is unconfirmed or data value forming part of a malfunction that is considered too small to affect the overall quality of the data object of which it is a part. [Used when no replicate measurements were available to check the quality of the data].
- 3: Probably Bad Value: Data value recognized as unusual during quality control that forms part of a feature that is probably inconsistent with real phenomena. [Not used].
- 4: Bad Value: An obviously erroneous data value. [Used when a soluble nickel concentration was much greater than the dissolved nickel concentration measured].
- 5: Changed Value: Data value adjusted during quality control. Best practice strongly recommends that the value before the change be preserved in the data or its accompanying metadata. [Not used].
- 6: Value Below Detection Limit: The level of the measured phenomenon was less than the limit of detection (LOD) for the method employed to measure it. The accompanying value is the detection limit for the technique or zero if that value is unknown. [Not used].
- 7: Value in Excess: The level of the measured phenomenon was too large to be quantified by the technique employed to measure it. The accompanying value is the measurement limit for the technique. [Not used].
- 8: Interpolated Value: This value has been derived by interpolation from other values in the data object. [Not used].
- 9: Missing Value: The data value is missing. Any accompanying value will be a magic number representing absent data [When sample was not collected the notation 'na' for 'not applicable' was used; when sample collected but there is no result for this parameter, the notation 'nda' for 'no data available' was used].
- A: Value Phenomenon Uncertain: There is uncertainty in the description of the measured phenomenon associated with the value such as chemical species or biological entity. [Not used.]

NOTE: For at least one sample, the soluble nickel concentration measured was significantly higher than the total dissolved nickel concentration measured; flagged with "4: bad value" in the dataset.

GEOTRACES IDP:

The dissolved Nickel parameters have been registered in the GEOTRACES DOoR portal with the following names:

EN631: Ni_D_CONC_BOTTLE::fpar5o (nmol/kg)
AE1909: Ni_D_CONC_BOTTLE::8py4r6 (nmol/kg)
AE1921: Ni_D_CONC_BOTTLE::p5qm4p (nmol/kg)
AE1930: Ni_D_CONC_BOTTLE::y4bxhp (nmol/kg).

BCO-DMO Processing Description

- Imported original file "Dataset_BAIT_ParenteBuck_NiSpeciation.csv" into the BCO-DMO system.
- Marked "nda", "na", "ND", and "NAN" as missing data values (missing data are empty/blank in the final CSV file).
- Created ISO Date-Time column from original DATE_GMT and GMT fields.
- Split original Cruise_ID column into: CRUISE, PROJECT_CRUISE, and CRUISE_NAME.
- Saved the final file as "940164_v1_2019_bait_dissolved_nickel_speciation.csv".

Problem Description

For at least one sample, the soluble nickel concentration measured was significantly higher than the total dissolved nickel concentration measured; flagged with "4: bad value" in the dataset.

[[table of contents](#) | [back to top](#)]

Data Files

File
940164_v1_2019_bait_dissolved_nickel_speciation.csv (Comma Separated Values (.csv), 21.62 KB) MD5:3484ca979d02f3765f229341df738d24 Primary data file for dataset ID 940164, version 1

[[table of contents](#) | [back to top](#)]

Related Publications

Boiteau, R. M., Till, C. P., Ruacho, A., Bundy, R. M., Hawco, N. J., McKenna, A. M., ... Repeta, D. J. (2016). Structural Characterization of Natural Nickel and Copper Binding Ligands along the US GEOTRACES Eastern Pacific Zonal Transect. *Frontiers in Marine Science*, 3. doi:[10.3389/fmars.2016.00243](https://doi.org/10.3389/fmars.2016.00243)
Methods

Dupont, C. L., Buck, K. N., Palenik, B., & Barbeau, K. (2010). Nickel utilization in phytoplankton assemblages from contrasting oceanic regimes. *Deep Sea Research Part I: Oceanographic Research Papers*, 57(4), 553-566. <https://doi.org/10.1016/j.dsr.2009.12.014>
Methods

Ellwood, M. J., & Van den Berg, C. M. G. (2000). Zinc speciation in the Northeastern Atlantic Ocean. *Marine Chemistry*, 68(4), 295-306. [https://doi.org/10.1016/s0304-4203\(99\)00085-7](https://doi.org/10.1016/s0304-4203(99)00085-7) [https://doi.org/10.1016/S0304-4203\(99\)00085-7](https://doi.org/10.1016/S0304-4203(99)00085-7)
Methods

Lagerström, M. E., Field, M. P., Séguet, M., Fischer, L., Hann, S., & Sherrell, R. M. (2013). Automated on-line flow-injection ICP-MS determination of trace metals (Mn, Fe, Co, Ni, Cu and Zn) in open ocean seawater: Application to the GEOTRACES program. *Marine Chemistry*, 155, 71-80. doi:[10.1016/j.marchem.2013.06.001](https://doi.org/10.1016/j.marchem.2013.06.001)
Methods

Mellet, T., & Buck, K. N. (2020). Spatial and temporal variability of trace metals (Fe, Cu, Mn, Zn, Co, Ni, Cd, Pb), iron and copper speciation, and electroactive Fe-binding humic substances in surface waters of the eastern Gulf of Mexico. *Marine Chemistry*, 227: 103891. doi:[10.1016/j.marchem.2020.103891](https://doi.org/10.1016/j.marchem.2020.103891)
Methods

Parente, C. (2024). Dissolved nickel speciation at the Bermuda Atlantic Time-series Study (BATS) site, University of South Florida, Tampa, FL.
Results

Saito, M. A., & Moffett, J. W. (2001). Complexation of cobalt by natural organic ligands in the Sargasso Sea as determined by a new high-sensitivity electrochemical cobalt speciation method suitable for open ocean work. *Marine Chemistry*, 75(1-2), 49-68. doi:[10.1016/s0304-4203\(01\)00025-1](https://doi.org/10.1016/s0304-4203(01)00025-1)
Methods

Saito, M. A., Moffett, J. W., & DiTullio, G. R. (2004). Cobalt and nickel in the Peru upwelling region: A major flux of labile cobalt utilized as a micronutrient. *Global Biogeochemical Cycles*, 18(4), n/a-n/a. doi:[10.1029/2003gb002216](https://doi.org/10.1029/2003gb002216)
Methods

Sedwick, P. N., Sohst, B. M., Buck, K. N., Caprara, S., Johnson, R. J., Ohnemus, D. C., Sofen, L. E., Tagliabue, A., Twining, B. S., & Williams, T. E. (2023). Atmospheric Input and Seasonal Inventory of Dissolved Iron in the Sargasso Sea: Implications for Iron Dynamics in Surface Waters of the Subtropical Ocean. *Geophysical Research Letters*, 50(6). Portico. <https://doi.org/10.1029/2022GL102594>

Methods

Ussher, S. J., Achterberg, E. P., Sarthou, G., Laan, P., de Baar, H. J. W., & Worsfold, P. J. (2010). Distribution of size fractionated dissolved iron in the Canary Basin. *Marine Environmental Research*, 70(1), 46–55.

doi:[10.1016/j.marenvres.2010.03.001](https://doi.org/10.1016/j.marenvres.2010.03.001)

Methods

Van Den Berg, C. M. G., & Nimmo, M. (1987). Determination of interactions of nickel with dissolved organic material in seawater using cathodic stripping voltammetry. *Science of The Total Environment*, 60, 185–195.

[https://doi.org/10.1016/0048-9697\(87\)90415-3](https://doi.org/10.1016/0048-9697(87)90415-3)

Methods

[[table of contents](#) | [back to top](#)]

Parameters

Parameter	Description	Units
CRUISE	UNOLS cruise ID	unitless
PROJECT_CRUISE	BAIT project cruise number	unitless
CRUISE_NAME	GEOTRACES cruise ID (GApr13) and leg number	unitless
Station	Hydrocast station identifier	unitless
SAMPLE_ID	Unique identifier for each water-column sample	unitless
ISO_DateTime_UTC	Recovery date and time (UTC) in ISO 8601 format	unitless
DATE_GMT	Hydrocast recovery date (GMT)	unitless
GMT	Hydrocast recovery time (GMT)	unitless
LATITUDE	Position when sample was collected in decimal degrees North	decimal degrees
LONGITUDE	Position when sample was collected in decimal degrees East	decimal degrees
PLATFORM	Sampling system used. TMC CTD = trace metal CTD rosette.	unitless
PRESSURE	In-situ pressure from CTD	decibar (db)
DEPTH	Sample collection depth estimated from pressure	meters (m)

Ni_D_CONC	Average total dissolved nickel (<0.2 micrometers) concentration in replicate sample analyses. These data have been registered in the GEOTRACES DOoR portal with the following names: EN631 = Ni_D_CONC_BOTTLE::fpar5o (nmol/kg). AE1909 = Ni_D_CONC_BOTTLE::8py4r6 (nmol/kg). AE1921 = Ni_D_CONC_BOTTLE::p5qm4p (nmol/kg). AE1930 = Ni_D_CONC_BOTTLE::y4bxhp (nmol/kg).	nanomoles per liter (nM)
Ni_D_STDEV	Standard deviation of average total dissolved nickel (<0.2 micrometers) concentration in replicate sample analyses	nanomoles per liter (nM)
Ni_D_FLAG	Quality flag for Ni_D_CONC	unitless
Ni_DL_CONC	Average labile dissolved nickel (<0.2 micrometers) concentration in replicate sample analyses	nanomoles per liter (nM)
Ni_DL_STDEV	Standard deviation of average labile dissolved nickel (<0.2 micrometers) concentration in replicate sample analyses	nanomoles per liter (nM)
Ni_DL_FLAG	Quality flag for Ni_DL_CONC	unitless
Ni_S_CONC	Concentration of soluble nickel (<0.02 micrometers)	nanomoles per liter (nM)
Ni_S_STDEV	Standard deviation of soluble nickel (<0.02 micrometers) concentration in replicate sample analyses; not used, no replicates.	nanomoles per liter (nM)
Ni_S_FLAG	Quality flag for Ni_S_CONC	unitless

[[table of contents](#) | [back to top](#)]

Instruments

Dataset-specific Instrument Name	BioAnalytical Systems (BASi) controlled growth hanging mercury drop electrode (CGME)
Generic Instrument Name	BASi Controlled Growth Mercury Electrode
Dataset-specific Description	BioAnalytical Systems (BASi) controlled growth hanging mercury drop electrode (CGME) interfaced with an Epsilon 2 analyzer: A BASi CGME was used to measure labile dissolved Ni concentrations.
Generic Instrument Description	Bioanalytical Systems (BASi) Mercury drop electrodes are generated by the BASi Controlled Growth Mercury Electrode (CGME) in three modes: DME (Dropping Mercury Electrode) - mercury is allowed to flow freely from the reservoir down the capillary and so the growth of the mercury drop and its lifetime is controlled by gravity. (The optional 100 um capillary is recommended for this mode.) SMDE (Static Mercury Drop Electrode) - the drop size is determined by the length of time for which the fast-response capillary valve is opened, and the drop is dislodged by a drop knocker. The dispense/knock timing is microprocessor-controlled and is typically coordinated with the potential pulse or square-wave waveform. This mode can also be used to generate the Hanging Mercury Drop Electrode required for stripping experiments. CGME (Controlled Growth Mercury Electrode) - the mercury drop is grown by a series of pulses that open the capillary valve. The number of pulses, their duration, and their frequency can be varied by PC control, providing great flexibility in both the drop size and its rate of growth. This CGME mode can be used for both polarographic and stripping experiments. http://www.basinc.com/products/ec/cgme.php

Dataset-specific Instrument Name	SBE 19 plus, SeaBird Electronics
Generic Instrument Name	CTD Sea-Bird
Generic Instrument Description	A Conductivity, Temperature, Depth (CTD) sensor package from SeaBird Electronics. This instrument designation is used when specific make and model are not known or when a more specific term is not available in the BCO-DMO vocabulary. Refer to the dataset-specific metadata for more information about the specific CTD used. More information from: http://www.seabird.com/

Dataset-specific Instrument Name	Niskin-X samplers (General Oceanics)
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	Elemental Scientific SeaFAST SP3
Generic Instrument Name	SeaFAST Automated Preconcentration System
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).

Dataset-specific Instrument Name	ICP-MS, Thermo Fisher Scientific ElementXR
Generic Instrument Name	Thermo Scientific ELEMENT XR high resolution inductively coupled plasma mass spectrometer
Generic Instrument Description	A high-resolution (HR) inductively coupled plasma (ICP) mass spectrometer (MS) composed of a dual mode secondary electron multiplier (SEM) and a Faraday detector. The ELEMENT XR instrument has a dynamic range of 5×10^7 to 1×10^{12} counts per second (cps), and allows simultaneous measurement of elements at concentrations over 1000 ug/g.

[[table of contents](#) | [back to top](#)]

Deployments

EN631

Website	https://www.bco-dmo.org/deployment/869159
Platform	R/V Endeavor
Report	https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/endeavor_en631.pdf
Start Date	2019-03-10
End Date	2019-03-15
Description	See additional cruise information at the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/EN631

AE1909

Website	https://www.bco-dmo.org/deployment/869175
Platform	R/V Atlantic Explorer
Report	https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/atlanticexplorer_ae1909.pdf
Start Date	2019-05-11
End Date	2019-05-17
Description	See additional cruise information at the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/AE1909

AE1930

Website	https://www.bco-dmo.org/deployment/869177
Platform	R/V Atlantic Explorer
Report	https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/atlanticexplorer_ae1930.pdf
Start Date	2019-11-15
End Date	2019-11-21
Description	See additional cruise information at the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/AE1930

AE1921

Website	https://www.bco-dmo.org/deployment/869176
Platform	R/V Atlantic Explorer
Report	https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/atlanticexplorer_ae1921.pdf
Start Date	2019-08-16
End Date	2019-08-22
Description	See additional cruise information at the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/AE1921

[[table of contents](#) | [back to top](#)]

Project Information

NSFGEO-NERC: Collaborative Research: Using Time-series Field Observations to Constrain an Ocean Iron Model (BAIT)

Coverage: Bermuda Atlantic Time-Series Study region, waters of the western Subtropical North Atlantic Gyre (ca. 30°N-33°N, 62°W-65°W)

NSF and NERC Award Abstract:

Iron is an essential nutrient for the growth of phytoplankton in the oceans. As such, iron plays key roles in regulating marine primary production and the cycling of carbon. It is thus important that models of ocean biology and chemistry consider iron, in order to explore past, present and future variations in marine productivity and the role of the ocean in the global carbon cycle. In this joint project involving researchers in the U.S. and the U.K., supported by both NSF and the Natural Environment Research Council (U.K.), field data from the Bermuda Atlantic Time-series Study (BATS) region will be combined with an established, state-of-the-art ocean biogeochemical model. By leveraging the known seasonal-scale physical, chemical and biological changes in the BATS region, the oceanographic context provided by the BATS core data, and an existing model of the regional physical circulation, the proposed study will yield process-related information that is of general applicability to the open ocean. In particular, the proposed research will focus on understanding the atmospheric input, biological uptake, regeneration and scavenging removal of dissolved iron in the oceanic water column, which have emerged as major uncertainties in the ocean iron cycle. The project will include significant educational and training contributions at the K-12, undergraduate, graduate and postdoctoral levels, as well as public outreach efforts that aim to explain the research and its importance.

The ability of ocean models to simulate iron remains crude, owing to an insufficient understanding of the mechanisms that drive variability in dissolved iron, particularly the involvement of iron-binding ligands, colloids and particles in the surface input, biological uptake, regeneration and scavenging of dissolved iron in the upper ocean. Basin-scale data produced by the GEOTRACES program provide an important resource for testing and improving models and, by extension, our mechanistic understanding of the ocean iron cycle. However such data provide only quasi-synoptic 'snapshots', which limits their utility in isolating and identifying the processes that control dissolved iron in the upper ocean. The proposed research aims to provide mechanistic insight into these governing processes by combining time-series data from the BATS region with numerical modeling experiments.

Specifically, seasonally resolved data on the vertical (upper 2,000 meters) and lateral (tens of kilometers) distributions of particulate, dissolved, colloidal, soluble and ligand-bound iron species will be obtained from the chemical analysis of water column samples collected during five cruises, spanning a full annual cycle, shared with the monthly BATS program cruises. These data, along with ancillary data from the BATS program, will be used to test and inform numerical modeling experiments, and thus derive an improved understanding of the mechanisms that control the distribution and dynamics of dissolved iron in the oceanic water column.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

This is a project jointly funded by the National Science Foundation's Directorate for Geosciences (NSF/GEO) and the National Environment Research Council (NERC) of the United Kingdom (UK).

[[table of contents](#) | [back to top](#)]

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.

[[table of contents](#) | [back to top](#)]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829833
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829777
NSF Division of Ocean Sciences (NSF OCE)	OCE-2310573

[[table of contents](#) | [back to top](#)]