Dissolved iron-binding ligand concentrations and conditional stability constants in surface and water column samples collected on US GEOTRACES GP17-OCE cruise (R/V Roger Revelle RR2214) in the South Pacific and Southern Oceans from Dec 2022 to Jan 2023

Website: https://www.bco-dmo.org/dataset/993204
Data Type: Cruise Results
Version: 1
Version Date: 2026-01-30

Project
» Collaborative Research: U.S. GEOTRACES GP17-OCE and GP17-ANT: Characterizing iron-binding organic ligands in the Southern Ocean and implications for iron cycling in the global ocean (GP17-OCE and GP17-ANT organic iron-binding ligands)
» US GEOTRACES GP17 Section: South Pacific and Southern Ocean (GP17-OCE) (GP17-OCE)

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

Contributors	Affiliation	Role
Buck, Kristen Nicolle	Oregon State University (OSU)	Principal Investigator, Contact, Data Manager
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Abstract

Iron is an essential micronutrient for marine life, and its binding by organic binding ligands is one of the main drivers of its distribution across the world ocean. This dataset includes the concentration and conditional stability constant of dissolved iron-binding ligands in the samples collected during the U.S. GEOTRACES GP17-OCE cruise. The objective of the cruise was to investigate the distribution of trace metals and dependent variables in a vast region of the South Pacific and Southern Ocean. The cruise departed Tahiti (French Polynesia) on December 1, 2022, and arrived in Punta Arenas (Chile) on January 25, 2023, crossing the Western South Pacific gyre, the Pacific-Antarctic ridge, the Southern Pacific Ocean, and the Chilean margin. Seawater samples were collected using trace metal clean techniques and stored frozen (-20 degrees Celsius) until analysis by Dr. Léo Mahieu in Kristen Buck's Elemental Ocean Lab, Oregon State University. The regions crossed during this transect represent a diversity of nutrient regimes, from oligotrophic to high nutrient-low chlorophyll systems, and deep waters were influenced by different hydrothermal systems, namely the East Pacific rise and the Pacific Antarctic ridge. This transect also crossed regions of intermediate and mode water mass formation, and the dynamic frontal system separating the warm South Pacific Ocean and the cold Southern Ocean. This cruise was a unique opportunity to investigate this vast and sparsely studied region, and our observations highlight potential processes leading to variations in iron-binding ligand characteristics along the water column across regions, fronts, nutrient regimes, hydrothermal influence, and water masses.

Table of Contents

- [Instruments]
- [Deployments]
- [Project Information]
- [Program Information]
- [Funding]

Coverage

Location: South Pacific and Southern Oceans
Spatial Extent: **N**:-19.9999 **E**:-75.0971 **S**:-67.0002 **W**:-152.0003
Temporal Extent: 2022-12-03 - 2023-01-24

Methods & Sampling

Sample Collection:
This work was funded by the U.S. National Science Foundation (NSF) and the samples collected on the U.S. GEOTRACES GP17-OCE cruise across the South Pacific and Southern Ocean onboard the R/V Roger Revelle from December 1, 2022 until January 25, 2023 (cruise ID RR2214). Water column sampling was accomplished with a trace-metal clean towed fish (Mellett and Buck, 2020) and a rosette equipped with 12-liter (L) GO-Flo bottles (General Oceanics; Cutter et al., 2017). The seawater was filtered inline through a 0.2-micrometer (µm) (Pall Acropak) capsule filter, collected in acid-clean Milli-Q conditioned 500 milliliter (mL) fluorinated high-density polyethylene (FLPE; Nalgene) bottles, and stored frozen at -20 degrees Celsius (°C) immediately after collection and until analysis (e.g., Buck et al., 2018). 20 full-depth profiles were collected for iron-binding ligands (483 samples).

Analysis of iron-binding ligands:
The samples were prepared and analyzed following an established method (Rue and Bruland 1995; Buck et al. 2007, 2012; Mahieu et al. 2024). The samples were thawed overnight at room temperature in the dark prior to analysis. Aliquots of 10 mL of sample were placed in 16 conditioned tubes (50 mL, MetalFree, Labcon) and spiked with 50 microliters (µL) of a 1.5 M borate acid (99 + %, Thermo Scientific) in 0.4 M ammonium (Optima, Fisher Chemical) buffer for a final pH of 8.2. The aliquots were then spiked with iron standard (prepared by dilution of atomic absorption spectrometry grade, AA; Fisher Chemical in 0.024 M trace metal grade HCl) for final concentration of 0, 0, 0.1, 0.25, 0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4, 5, 7.5, 10 and 15 nanomolar (nM) in each 10 mL of sample. After at least 2 hours of equilibration, the tubes were spiked with 50 µL of a 5 millimolar (mM) salycilaldoxime (98 + %, TCI America) solution made in methanol (LC/MS Grade Optima, Fisher Chemical) for a final concentration of 25 µM and left to equilibrate for at least 15 minutes before analysis.

Each aliquot was analyzed after being placed in a fluorinated ethylene propylene (FEP) cell (Princeton Applied Research) on a controlled mercury growth electrode (CGME) from BioAnalytical Systems, Inc. (BASi) set on drop size 14 in Static Mercury Drop Electrode (SMDE) mode and equipped with a platinum wire counter electrode, a chloride/silver chloride reference electrode, and commercially available quadruple-distilled elemental mercury (Bethlehem Apparatus) as working electrode. The CGME was controlled by an EClipse potentiostat (BASi) or an Epsilon Ɛ2 electrochemical analyzer (BASi); 2 systems were used simultaneously. The following parameters were applied through the software EpsionEC (BASi): analysis with differential pulse adsorptive cathodic stripping voltammetry (DP-AdCSV), deposition at +0.05 volts (V) while stirring, 15 seconds of quiet time (no stirring), stripping from 0 to -0.85 V with a 6 mV step, 50 mV amplitude, 35 millisecond (ms) pulse width and 200 ms pulse period (Mahieu et al. 2024).

The height of the reduction peak was determined using an automated procedure (Mahieu et al. 2024). Briefly, the 4th derivative of the scan was produced through the software ECDSoft (Omanović and Branica, 1998), and the peak height defined with a linear baseline on adaptive scan. The peak heights were then compiled in a custom-made Excel spreadsheet, and the data fitted on the software ProMCC (Omanović et al., 2015) using Complete Complexation fitting model and considering a detection of α_{AL} of 79 (e.g., Buck et al., 2007).

Data Processing Description

Data were flagged using the SeaDataNet quality flag scheme following GEOTRACES guidelines, see: https://www.geotraces.org/geotraces-quality-flag-policy/. Additional notes specific to the application of these flags to this project are noted in brackets [...].

0: No Quality Control: No quality control procedures have been applied to the data value. This is the initial status for all data values entering the working archive. [Not used].

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 analyses that included replicate samples].

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 or reference samples 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. [Not used].

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. [Not detected: Used to denote ligand classes not detected in the samples. These values are represented by "nd"].

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 was 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.]

BCO-DMO Processing Description

- Imported original file "Fe-ligands_GP17-OCE_BCO-DMO_Mahieu_Buck.xlsx" into the BCO-DMO system.
- Flagged "nd" as a missing data value (missing data are empty/blank in the final CSV file).
- Renamed fields to comply with BCO-DMO naming conventions.
- Converted date format to YYYY-MM-DD.
- Saved the final file as "993204_v1_gp17-oce_fe-binding_ligands.csv".

[table of contents | back to top]

Related Publications

Buck, K. N., Lohan, M. C., Berger, C. J. M., & Bruland, K. W. (2007). Dissolved iron speciation in two distinct river plumes and an estuary: Implications for riverine iron supply. Limnology and Oceanography, 52(2), 843–855. doi:10.4319/lo.2007.52.2.0843
Methods

Buck, K. N., Moffett, J., Barbeau, K. A., Bundy, R. M., Kondo, Y., & Wu, J. (2012). The organic complexation of iron and copper: an intercomparison of competitive ligand exchange-adsorptive cathodic stripping voltammetry (CLE-ACSV) techniques. Limnology and Oceanography: Methods, 10(7), 496–515. doi:10.4319/lom.2012.10.496
Methods

Buck, K. N., Sedwick, P. N., Sohst, B., & Carlson, C. A. (2018). Organic complexation of iron in the eastern tropical South Pacific: Results from US GEOTRACES Eastern Pacific Zonal Transect (GEOTRACES cruise GP16).

Marine Chemistry, 201, 229–241. https://doi.org/10.1016/j.marchem.2017.11.007
Methods

Cutter, G. A., & Bruland, K. W. (2012). Rapid and noncontaminating sampling system for trace elements in global ocean surveys. Limnology and Oceanography: Methods, 10(6), 425–436. doi:10.4319/lom.2012.10.425
Methods

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. Version 3, August 2017. Toulouse, France, GEOTRACES International Project Office, 139pp. & Appendices. DOI: http://dx.doi.org/10.25607/OBP-2
Methods

Mahieu, L., Omanović, D., Whitby, H., Buck, K. N., Caprara, S., & Salaün, P. (2024). Recommendations for best practice for iron speciation by competitive ligand exchange adsorptive cathodic stripping voltammetry with salicylaldoxime. Marine Chemistry, 259, 104348. https://doi.org/10.1016/j.marchem.2023.104348
Methods

Mellett, 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
Methods

Omanović, D., Branica, M., 1998. Automation of voltammetric measurements by polarographic analyser PAR 384B. Croatica Chemica Acta. https://fulir.irb.hr/1160/
Methods

Omanović, D., Garnier, C., & Pižeta, I. (2015). ProMCC: An all-in-one tool for trace metal complexation studies. Marine Chemistry, 173, 25–39. doi:10.1016/j.marchem.2014.10.011
Methods

Rue, E. L., & Bruland, K. W. (1995). Complexation of iron(III) by natural organic ligands in the Central North Pacific as determined by a new competitive ligand equilibration/adsorptive cathodic stripping voltammetric method. Marine Chemistry, 50(1-4), 117–138. doi:10.1016/0304-4203(95)00031-l
Methods

[table of contents | back to top]

Parameters

Parameter	Description	Units
CRUISE	Cruise identifier	unitless
SAMPLE_ID	GEOTRACES sample ID number	unitless
STATION	Station number	unitless
DATE	Date of field sampling deployment	unitless
LATITUDE	Ship's latitude when water was collected	decimal degrees North
LONGITUDE	Ship's longitude when water was collected	decimal degrees East

PLATFORM	Sampling system used for incubation setup water collection. TMC CTD = trace metal clean CTD rosette. FISH = towfish.	unitless
DEPTH	Depth in meters of sample collection. Depth of towfish sampling estimated at 2 meters in all cases.	meters (m)
Fe_D_CONC_BOTTLE	Dissolved iron concentration considered for the interpretation of the iron-binding ligand titration.	nanomole per liter (nM)
DFe_D_DATA_PRODUCER	Method and laboratory originating the dissolved iron data considered for the interpretation of the iron-binding ligand titration. The values are 'FIA Sedwick Lab', 'ICP-MS Sedwick Lab', or 'ICP-MS Fitzsimmons Lab'.	unitless
L1Fe_D_CONC_BOTTLE_ritefe	Iron-binding ligand concentration falling in the strong class (log K > 11.8) measured in the bottle samples.	nM
L1_FLAG_BOTTLE_ritefe	Quality flag for strong iron-binding ligand concentration measured in the bottle samples.	unitless
L1_95pcnt_CI_BOTTLE_ritefe	Error of the strong iron-binding ligand concentration measured in the bottle samples. If one analysis was performed, the value corresponds to the error provided by the fitting software. If more than one analysis was performed, the value corresponds to the standard deviation of the results from the different analysis.	nM
L1Fe_D_LogK_BOTTLE_pjmh3q	Iron-binding ligand conditional binding strength falling in the strong class (log K > 11.8) measured in the bottle samples.	unitless
Log_K1_FLAG_BOTTLE_pjmh3q	Quality flag for strong iron-binding ligand conditional binding strength measured in the bottle samples.	unitless
Log_K1_95pcnt_CI_BOTTLE_pjmh3q	Error of the strong iron-binding ligand conditional binding strength measured in the bottle samples. If one analysis was performed, the value corresponds to the error provided by the fitting software. If more than one analysis was performed, the value corresponds to the standard deviation of the results from the different analysis.	unitless
L2Fe_D_CONC_BOTTLE_mwzurv	Iron-binding ligand concentration falling in the intermediate class (11.1 < log K < 11.8) measured in the bottle samples.	nM
L2_FLAG_BOTTLE_mwzurv	Quality flag for intermediate iron-binding ligand concentration measured in the bottle samples.	unitless

L2_95pcnt_CI_BOTTLE_mwzurv	Error of the intermediate iron-binding ligand concentration measured in the bottle samples. If one analysis was performed, the value corresponds to the error provided by the fitting software. If more than one analysis was performed, the value corresponds to the standard deviation of the results from the different analysis.	nM
L2Fe_D_LogK_BOTTLE_cry7lm	Iron-binding ligand conditional binding strength falling in the intermediate class (11.1 < log K < 11.8) measured in the bottle samples.	unitless
Log_K2_FLAG_BOTTLE_cry7lm	Quality flag for intermediate iron-binding ligand conditional binding strength measured in the bottle samples.	unitless
Log_K2_95pcnt_CI_BOTTLE_cry7lm	Error of the intermediate iron-binding ligand conditional binding strength measured in the bottle samples. If one analysis was performed, the value corresponds to the error provided by the fitting software. If more than one analysis was performed, the value corresponds to the standard deviation of the results from the different analysis.	unitless
L3Fe_D_CONC_BOTTLE	Iron-binding ligand concentration falling in the weak class (log K < 11.1) measured in the bottle samples.	nM
L3_FLAG_BOTTLE	Quality flag for weak iron-binding ligand concentration measured in the bottle samples.	unitless
L3_95pcnt_CI_BOTTLE	Error of the weak iron-binding ligand concentration measured in the bottle samples. If one analysis was performed, the value corresponds to the error provided by the fitting software. If more than one analysis was performed, the value corresponds to the standard deviation of the results from the different analysis.	nM
L3Fe_D_LogK_BOTTLE	Iron-binding ligand conditional binding strength falling in the weak class (log K < 11.1) measured in the bottle samples.	unitless
Log_K3_FLAG_BOTTLE	Quality flag for weak iron-binding ligand conditional binding strength measured in the bottle samples.	unitless
Log_K3_95pcnt_CI_BOTTLE	Error of the weak iron-binding ligand conditional binding strength measured in the bottle samples. If one analysis was performed, the value corresponds to the error provided by the fitting software. If more than one analysis was performed, the value corresponds to the standard deviation of the results from the different analysis.	unitless

L1Fe_D_CONC_FISH_b7l83q	Iron-binding ligand concentration falling in the strong class (log K > 11.8) measured in the fish samples.	nM
L1_FLAG_FISH_b7l83q	Quality flag for strong iron-binding ligand concentration measured in the fish samples.	unitless
L1_95pcnt_CI_FISH_b7l83q	Error of the strong iron-binding ligand concentration measured in the fish samples. If one analysis was performed, the value corresponds to the error provided by the fitting software. If more than one analysis was performed, the value corresponds to the standard deviation of the results from the different analysis.	nM
L1Fe_D_LogK_FISH_j8v4ij	Iron-binding ligand conditional binding strength falling in the strong class (log K > 11.8) measured in the fish samples.	unitless
Log_K1_FLAG_FISH_j8v4ij	Quality flag for strong iron-binding ligand conditional binding strength measured in the fish samples.	unitless
Log_K1_95pcnt_CI_FISH_j8v4ij	Error of the strong iron-binding ligand conditional binding strength measured in the fish samples. If one analysis was performed, the value corresponds to the error provided by the fitting software. If more than one analysis was performed, the value corresponds to the standard deviation of the results from the different analysis.	unitless
L2Fe_D_CONC_FISH_srmfqm	Iron-binding ligand concentration falling in the intermediate class (11.1 < log K < 11.8) measured in the fish samples.	nM
L2_FLAG_FISH_srmfqm	Quality flag for intermediate iron-binding ligand concentration measured in the fish samples.	units
L2_95pcnt_CI_FISH_srmfqm	Error of the intermediate iron-binding ligand concentration measured in the fish samples. If one analysis was performed, the value corresponds to the error provided by the fitting software. If more than one analysis was performed, the value corresponds to the standard deviation of the results from the different analysis.	nM
L2Fe_D_LogK_FISH_cu47vs	Iron-binding ligand conditional binding strength falling in the intermediate class (11.1 < log K < 11.8) measured in the fish samples.	unitless
Log_K2_FLAG_FISH_cu47vs	Quality flag for intermediate iron-binding ligand conditional binding strength measured in the fish samples.	unitless

Log_K2_95pcnt_CI_FISH_cu47vs	Error of the intermediate iron-binding ligand conditional binding strength measured in the fish samples. If one analysis was performed, the value corresponds to the error provided by the fitting software. If more than one analysis was performed, the value corresponds to the standard deviation of the results from the different analysis.	unitless
L3Fe_D_CONC_FISH	Iron-binding ligand concentration falling in the weak class (log K < 11.1) measured in the fish samples.	nM
L3_FLAG_FISH	Quality flag for weak iron-binding ligand concentration measured in the fish samples.	unitless
L3_95pcnt_CI_FISH	Error of the weak iron-binding ligand concentration measured in the fish samples. If one analysis was performed, the value corresponds to the error provided by the fitting software. If more than one analysis was performed, the value corresponds to the standard deviation of the results from the different analysis.	nM
L3Fe_D_LogK_FISH	Iron-binding ligand conditional binding strength falling in the weak class (log K < 11.1) measured in the fish samples.	unitless
Log_K3_FLAG_FISH	Quality flag for weak iron-binding ligand conditional binding strength measured in the fish samples.	unitless
Log_K3_95pcnt_CI_FISH	Error of the weak iron-binding ligand conditional binding strength measured in the fish samples. If one analysis was performed, the value corresponds to the error provided by the fitting software. If more than one analysis was performed, the value corresponds to the standard deviation of the results from the different analysis.	unitless
LFetot	Iron-binding ligand concentration measured in the sample for any conditional stability constant. ‘na’ for ‘not applicable’ used when no sample was collected for this parameter, ‘dna’ if no data was collected.	nM eq Fe
LFetot_95pcnt_CI	Error of the iron-binding ligand concentration.	nM eq Fe
eLFetot	Excess iron-binding ligand concentration measured in the sample for any conditional stability constant (equal to iron-binding ligand concentration minus dissolved iron concentration).	nM eq Fe
eLFe1	Excess iron-binding ligand concentration measured in the sample falling in the strong class (log K > 11.8) (equal to strong iron-binding ligand concentration minus dissolved iron concentration).	nM eq Fe

Log_Ktot	Iron-binding ligand conditional binding strength (no separation by classes).	unitless
Log_Ktot_95pcnt_CI	Error of the iron-binding ligand conditional binding strength.	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	controlled mercury growth electrode (CGME) from BioAnalytical Systems, Inc. (BASi)
Generic Instrument Name	BASi Controlled Growth Mercury Electrode
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 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	Epsilon Ɛ2 electrochemical analyzer (BASi)
Generic Instrument Name	BASi EC-epsilon 2 Autoanalyzer
Dataset-specific Description	The CGME was controlled by an EClipse potentiostat (BASi) or an Epsilon Ɛ2 electrochemical analyzer (BASi); 2 systems were used simultaneously.
Generic Instrument Description	The Bioanalytical Systems EC epsilon is a family of potentiostat/galvanostats for electrochemistry. The most basic epsilon instrument can be used for standard techniques, as well as chronopotentiometry for materials characterization (e.g., characterization of transition metal complexes by cyclic voltammetry and controlled potential electrolysis, or of biosensors by cyclic voltammetry and constant potential amperometry). Pulse, square wave, and stripping techniques can be added by a software upgrade, and a second channel can be added by a hardware upgrade.

Dataset-specific Instrument Name	EClipse potentiostat (BASi)
Generic Instrument Name	BASi Epsilon Eclipse potentiostat/galvanostat/bipotentiostat
Dataset-specific Description	The CGME was controlled by an EClipse potentiostat (BASi) or an Epsilon Ɛ2 electrochemical analyzer (BASi); 2 systems were used simultaneously.
Generic Instrument Description	The BASi Epsilon Eclipse is an electrochemical analyser. It is a potentiostat/galvanostat with a second working electrode for bipotentiostat measurements. The instrument includes software which allows for the use of different techniques including different types of voltammetry, coulometry, amperometry, electrolysis, potentiometry, and polarography. The potentiostat is made up of 2 applied potential channels with 16 and 8 bit dynamic digital-to-analogue converters (DAC) with ranges of 3.275 V at 0.1 mV resolution or 10 V at 0.33 mV resolution, and 2.55 V at 10 mV resolution, respectively. The current to voltage converter has full scale sensitivity of 1 nA, 10 nA, 100 nA, 1 uA, 10 uA, 100 uA, 1 mA, 10 mA, and 100 mA, and a sampling rate of 50 Hz. The galvanostat has an applied current of 50 pA to 50 mA, a range of 10 V, and a measured potential resolution of 0.02 mV.

Dataset-specific Instrument Name	eabird 9/11+ carousel/CTD
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Dataset-specific Description	Depth profile samples were collected with the GEOTRACES Trace Element Carousel sampling system (GTC) that includes an A-frame, a Seabird 9/11+ carousel/CTD equipped with 24 Go-Flo bottles (General Oceanics) of 12 L, a Dynacon winch with 7300 m of Vectran cable with conductors, and clean lab van for bottle sub-sampling (Cutter and Bruland 2012).
Generic Instrument Description	The Sea-Bird SBE 911 plus is a type of CTD instrument package for continuous measurement of conductivity, temperature and pressure. The SBE 911 plus includes the SBE 9plus Underwater Unit and the SBE 11plus Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 plus and SBE 11 plus is called a SBE 911 plus. The SBE 9 plus uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 plus and SBE 4). The SBE 9 plus CTD can be configured with up to eight auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). more information from Sea-Bird Electronics

Dataset-specific Instrument Name	trace-metal clean towed fish
Generic Instrument Name	GeoFish Towed near-Surface Sampler
Dataset-specific Description	Surface samples were collected using the Fitzsimmons Lab towfish system of weighted torpedo (PVC). The towfish was deployed on the side of the ship using a 19’ powder-coated aluminum boom, an Amsteel blue line and an urethane-coated aluminum block (Sherman-Reilly, 74 Series, 16’’ diameter). Seawater was pumped through the tubing with a Teflon bellows pump powered by the ship compressed air.
Generic Instrument Description	The GeoFish towed sampler is a custom designed near surface (

Dataset-specific Instrument Name	rosette equipped with 12-L GO-Flo bottles
Generic Instrument Name	GO-FLO Teflon Trace Metal Bottle
Generic Instrument Description	GO-FLO Teflon-lined Trace Metal free sampling bottles are used for collecting water samples for trace metal, nutrient and pigment analysis. The GO-FLO sampling bottle is designed specifically to avoid sample contamination at the surface, internal spring contamination, loss of sample on deck (internal seals), and exchange of water from different depths.

[table of contents | back to top]

Deployments

RR2214

Website	https://www.bco-dmo.org/deployment/905754
Platform	R/V Roger Revelle
Report	https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/rogerrevelle_rr2214.pdf
Start Date	2022-12-01
End Date	2023-01-25
Description	The U.S. GEOTRACES GP17-OCE expedition departed Papeete, Tahiti (French Polynesia) on December 1st, 2022 and arrived in Punta Arenas, Chile on January 25th, 2023. The cruise took place in the South Pacific and Southern Oceans aboard the R/V Roger Revelle with a team of 34 scientists led by Ben Twining (Chief Scientist), Jessica Fitzsimmons, and Greg Cutter (Co-Chief Scientists). GP17 was planned as a two-leg expedition, with its first leg (GP17-OCE) as a southward extension of the 2018 GP15 Alaska-Tahiti expedition and a second leg (GP17-ANT; December 2023-January 2024) into coastal and shelf waters of Antarctica's Amundsen Sea. The GP17-OCE section encompassed three major transects: (1) a southbound pseudo-meridional section (~152-135 degrees West) from 20 degrees South to 67 degrees South; (2) an eastbound zonal transect from 135 degrees West to 100 degrees West; (3) and a northbound section returning to Chile (100-75 degrees West). Additional cruise information is available from the following sources: R2R: https://www.rvdata.us/search/cruise/RR2214 CCHDO: https://cchdo.ucsd.edu/cruise/33RR20221201 More information can also be found at: https://usgeotraces.ldeo.columbia.edu/content/gp17-oce

[table of contents | back to top]

Project Information

Collaborative Research: U.S. GEOTRACES GP17-OCE and GP17-ANT: Characterizing iron-binding organic ligands in the Southern Ocean and implications for iron cycling in the global ocean (GP17-OCE and GP17-ANT organic iron-binding ligands)

NSF Award Abstract

Iron is an essential element for life and plays an important role in defining how much atmospheric carbon dioxide is taken up into the ocean by phytoplankton. However, iron cycling is closely governed by the chemistry of seawater; nearly all iron in seawater is associated with various unknown organic compounds, called iron-binding ligands, which impact whether and how iron is utilized by organisms and the distribution of iron throughout the ocean. Detail understanding of the cycling of organic iron-binding ligands is necessary to understand iron cycling in the oceans and the connections between iron cycling and atmospheric carbon. The proposed research will be carried out as a part of US GEOTRACES expedition to test the hypothesis that the Southern Ocean is a globally significant source of iron-binding organic ligands, and that different sources of these organic molecules lead to different iron-ligand characteristics. The US GEOTRACES program is a large collaborative effort to sample ocean systems at high resolution for a suite of key trace elements and isotopes. The South Pacific and Southern Ocean regions targeted by the upcoming US GEOTRACES GP17 cruises are important locations of water mass formation and the subsequent transport of carbon and nutrients to the global ocean. Organic ligands produced in these regions thus have important implications for the stabilization, reactivity, and residence time of iron along the path of global water mass circulation and could impact the global oceanic inventory of dissolved iron.

This project will measure the distribution of iron-binding organic ligands, and identify specific organic molecules that comprise these ligands, in field and experimental samples collected on upcoming US GEOTRACES cruises in the South Pacific (GP17-OCE) and Southern Ocean (GP17-ANT). These datasets will be utilized to conduct the first extensive intercalibration of the two most widely used approaches for characterizing iron-binding organic ligands, providing important insight into these datasets and how they can be synthesized to improve understanding of iron cycling in the oceans. All data from this project will be made publicly available. Project activities will provide educational and training opportunities for middle school, high school, undergraduate, and graduate students, and results will be shared with the public through the development of virtual reality modules and via local outreach events.

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.

US GEOTRACES GP17 Section: South Pacific and Southern Ocean (GP17-OCE) (GP17-OCE)

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

Coverage: Papeete, Tahiti to Punta Arenas, Chile

The U.S. GEOTRACES GP17-OCE expedition departed Papeete, Tahiti (French Polynesia) on December 1st, 2022 and arrived in Punta Arenas, Chile on January 25th, 2023. The cruise took place in the South Pacific and Southern Oceans aboard the R/V Roger Revelle (cruise ID RR2214) with a team of 34 scientists lead by Ben Twining (Chief Scientist), Jessica Fitzsimmons and Greg Cutter (Co-Chief Scientists). GP17 was planned as a two-leg expedition, with its first leg (GP17-OCE) as a southward extension of the 2018 GP15 Alaska-Tahiti expedition and a second leg (GP17-ANT; December 2023-January 2024) into coastal and shelf waters of Antarctica's Amundsen Sea.

The South Pacific and Southern Oceans sampled by GP17-OCE play critical roles in global water mass circulation and associated global transfer of heat, carbon, and nutrients. Specific oceanographic regions of interest for GP17-OCE included: the most oligotrophic gyre in the global ocean, the Antarctic Circumpolar Current (ACC) frontal region, the previously unexplored Pacific- Antarctic Ridge, the Pacific Deep Water (PDW) flow along the continental slope of South America, and the continental margin inputs potentially emanating from South America.

Further information is available on the US GEOTRACES website and in the cruise report (PDF).

NSF Project Title: Collaborative Research: Management and Implementation of US GEOTRACES GP17 Section: South Pacific and Southern Ocean (GP17-OCE)

NSF Award Abstract:
This award will support the management and implementation of a research expedition from Tahiti to Chile that will enable sampling for a broad suite of trace elements and isotopes (TEI) across oceanographic regions of importance to global nutrient and carbon cycling as part of the U.S. GEOTRACES program. GEOTRACES is a global effort in the field of Chemical Oceanography, the goal of which is to understand the distributions of trace elements and their isotopes in the ocean. Determining the distributions of these elements and isotopes will increase understanding of processes that shape their distributions, such as ocean currents and material fluxes, and also the processes that depend on these elements, such as the growth of phytoplankton and the support of ocean ecosystems. The proposed cruise will cross the South Pacific Gyre, the Antarctic Circumpolar Current, iron-limited Antarctic waters, and the Chilean margin. In combination with a proposed companion GEOTRACES expedition on a research icebreaker (GP17-ANT) that will be joined by two overlapping stations,

the team of investigators will create an ocean section from the ocean's most nutrient-poor waters to its highly-productive Antarctic polar region - a region that plays an outsized role in modulating the global carbon cycle. The expedition will support and provide management infrastructure for additional participating science projects focused on measuring specific external fluxes and internal cycling of TEIs along this section.

The South Pacific Gyre and Pacific sector of the Southern Ocean play critical roles in global water mass circulation and associated global transfer of heat, carbon, and nutrients, but they are chronically understudied for TEIs due to their remote locale. These are regions of strong, dynamic fronts where sub-surface water masses upwell and subduct, and biological and chemical processes in these zones determine nutrient stoichiometries and tracer concentrations in waters exported to lower latitudes. The Pacific sector represents an end member of extremely low external TEI surface fluxes and thus an important region to constrain inputs from the rapidly-changing Antarctic continent. Compared to other ocean basins, TEI cycling in these regions is thought to be dominated by internal cycling processes such as biological uptake, regeneration, and scavenging, and these are poorly represented in global ocean models. The cruise will enable funded investigators to address research questions such as: 1) what are relative rates of external TEI fluxes to this region, including dust, sediment, hydrothermal, and cryospheric fluxes? 2) What are the (micro) nutrient regimes that support productivity, and what impacts do biomass accumulation, export, and regeneration have on TEI cycling and stoichiometries of exported material? 3) What are TEI and nutrient stoichiometries of subducting water masses, and how do scavenging and regeneration impact these during transport northward? This management project has several objectives: 1) plan and coordinate a 55-day research cruise in 2021-2022; 2) use both conventional and trace-metal 'clean' sampling systems to obtain TEI samples, as well as facilitate sampling for atmospheric aerosols and large volume particles and radionuclides; 3) acquire hydrographic data and samples for salinity, dissolved oxygen, algal pigments, and macro-nutrients; and deliver these data to relevant repositories; 4) ensure that proper QA/QC protocols, as well as GEOTRACES intercalibration protocols, are followed and reported; 5) prepare the final cruise report to be posted with data; 6) coordinate between all funded cruise investigators, as well as with leaders of proposed GP17-ANT cruise; and 7) conduct broader impact efforts that will engage the public in oceanographic research using immersive technology. The motivations for and at-sea challenges of this work will be communicated to the general public through creation of immersive 360/Virtual Reality experiences, via a collaboration with the Texas A&M University Visualization LIVE Lab. Through Virtual Reality, users will experience firsthand what life and TEI data collection at sea entail. Virtual reality/digital games and 360° experiences will be distributed through GEOTRACES outreach websites, through PI engagement with local schools, libraries, STEM summer camps, and adult service organizations, and through a collaboration with the National Academy of Sciences.

[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-2300915
NSF Division of Ocean Sciences (NSF OCE)	OCE-2219551

[table of contents | back to top]