Concentrations of dissolved micronutrient trace metals (Fe, Zn, Ni, Cu, Cd, Pb, Mn) in seawater, sea ice, and melt ponds collected during the US GEOTRACES Arctic cruise (HLY1502; GN01) on USCGC Healy from August to October 2015

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Project
» U.S. Arctic GEOTRACES Study (U.S. GEOTRACES Arctic)
» GEOTRACES Arctic section: Dissolved micronutrient trace metal distributions and size partitioning (Arctic GN01 Diss Metals)

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

Contributors	Affiliation	Role
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Abstract
Concentrations of dissolved micronutrient trace metals (Fe, Zn, Ni, Cu, Cd, Pb, Mn) in seawater, sea ice, and melt ponds collected on the US GEOTRACES Arctic cruise (HLY1502, GN01) from August to October 2015.

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Coverage

Spatial Extent: **N**:89.994 **E**:179.804 **S**:60.166 **W**:-179.144
Temporal Extent: 2015-08-12 - 2015-10-07

Dataset Description

Concentrations of dissolved micronutrient trace metals (Fe, Zn, Ni, Cu, Cd, Pb, Mn) in seawater, sea ice, and melt ponds collected on the US GEOTRACES Arctic cruise (HLY1502, GN01) from August to October 2015.

These data have been published in the following:
Marsay et al., 2018 – Melt pond metal concentrations
Kadko et al., 2019 – Surface seawater metal concentrations
Jensen et al., 2019 – Dissolved Zn seawater concentrations
Zhang et al., 2019 – Dissolved Cd seawater concentrations
Charette et al., 2020 – Upper ocean dissolved metal concentrations
Jensen, 2020 (PhD Dissertation)

Acquisition Description

All trace metal-clean seawater samples in this dataset were collected following the prescribed US GEOTRACES protocol ("GEOTRACES cookbook": for more information see (Cutter et al., 2010; Cutter and Bruland, 2012)). Briefly, 24 Teflon-coated, acid-cleaned and preconditioned GO-FLO bottles were deployed on an epoxy-coated aluminum rosette and were tripped on ascent at 3 m/min. Once on deck, bottles were immediately capped with plastic shower caps on both ends to reduce contamination and subsequently kept in a clean sampling van under positive-pressure, HEPA-filtered air. All handling and subsampling was performed exclusively by designated, trace metal-clean personnel to preserve homogeneity and further reduce contamination.

During sampling for the GO-Flo samples, salinity and nutrient (unfiltered) samples were taken first, and then all Go-Flo bottles were pressurized to ~0.7 atm with HEPA-filtered air. Each bottle was fitted with an acid-cleaned and seawater-preconditioned 0.2 um AcroPak-200 capsule filter (Pall), and at least 500 mL was passed through each filter to rinse. Samples were collected in acid-cleaned (hydrochloric acid, 1 M (Fitzsimmons and Boyle, 2012)) LDPE bottles (Nalgene) after three 10% rinses of the bottle, cap, and threads and filled to the shoulder or as volume allowed.

In the absence of sea ice, surface samples were collected in trace metal clean fashion by taking a small boat upstream of the ship. The small boat was pointed into the oncoming current to sample "uncontaminated water" as it passed the boat, and a trained trace metal personnel wearing trace metal clean gloves and plastic sleeves submerged an acid-cleaned carboy under the water surface from the bow of the boat, always keeping the carboy pointed into the oncoming water. The carboy was immediately capped and bagged for transit back to the ship, where it was immediately filtered (0.2 um, Acropak-200) and sub-sampled into individual bottles, including our acid-clean 250 mL LDPE bottles.

A small subset of samples from designated "ice stations" (Stations 31, 33, 39, 43) were collected under the ice (approx. 1, 5, and 20 m) after the ice was drilled with a polypropylene/titanium trace metal coring system. Sampling was done using a polypropylene, battery-powered motor centrifugal pump with ½ inch FEP-lined Tygon tubing. Samples were collected and filtered (0.2 um, Acropak-200) into a 25 L acid-cleaned carboy and then sub-sampled back on the ship, including into our acid-clean 250 mL LDPE bottles, within 3 hours of collection.

At these same "ice stations", melt pond samples were collected (Marsay et al., 2018) by clearing surface snow with an acid-cleaned polyethylene shovel and then using a polyethylene/titanium trace metal coring system to drill through the upper ice. Melt pond water was pumped using a battery-powered polyethylene pump through pre-cleaned C-flex tubing into a pre-cleaned LDPE carboy. The melt pond sample in this carboy was filtered and sub-sampled into individual bottles, including our acid-clean 250 mL LDPE bottles, within 3 hours of collection.

Subsequently, all samples were acidified under clean air conditions to pH~2 with 0.012 M HCl (Optima, Fisher Scientific) within 1 week of sample collection and stored at room temperature until analyzed.

At least 9 months after acidification, samples were analyzed for trace metal (Fe, Ni, Cu, Zn, Pb, Cd, Mn) concentrations at Texas A&M University after pre-concentration on a SeaFAST-pico system (Elemental Scientific Inc.). This method follows a modified version of Lagerström et al. (2013) and is described completely for all elements in Jensen et al. (2020). Briefly, 10 mL of acidified seawater sample was weighed and then spiked with an isotope mixture containing 57Fe, 62Ni, 65Cu, 68Zn, 206Pb, and 111Cd. The mixture was then automatically loaded into the SeaFAST system. Monoisotopic metals such as Mn were measured via a 6-point standard curve using standards made up in low-metal seawater (maintained in-house) such that Mn concentrations spanned 0 to 10 nmol/kg; these standard curves were each run through the SeaFAST twice (once to start and once to end each run) as samples. The SeaFAST method buffers the acidified (pH~2) sample with a ~5.90 N ammonium acetate buffer (Optima, Fisher Scientific) to pH ~6.5 and loads the buffered mixture onto a pre-cleaned column containing Nobias PA1 resin (Sohrin et al., 2008). Each sample is then back-eluted with a solution of 10% (v/v) nitric acid and 1 ppb In (Optima, Fisher Scientific) to yield 400 uL, representing a 25-fold pre-concentration of each trace metal. Within days, each eluent is analyzed in low (204Pb, 206Pb, and 111Cd, 114Cd, 115In) and medium resolution (55Mn, 56Fe, 57Fe, 60Ni, 62Ni, 63Cu, 65Cu, 66Zn, 68Zn, 115In) on a Thermo Element XR high resolution ICP-MS in the Ken Williams Radiogenic Facility in the College of Geosciences at Texas A&M University.

Each sample run included ~80 aliquots from the SeaFAST. Every 10 SeaFAST samples on the XR, pure 10% (v/v) nitric with 1 ppb of 115In was run to extract a potential instrument blank coming from the instrument itself. Prior to running on the ICP-MS, the machine was “cleaned” with this mixture as a precaution against contamination from other samples, in addition to using a separate set of cones, nebulizer, spray chamber, and sample probe for SeaFAST samples only.

Processing Description

Data Processing:
The raw counts from the HR-ICP-MS analyses were first corrected for any instrument blank derived from the 10% nitric acid and In solution repeatedly analyzed during the instrumental analyses. Following this, each sample was corrected for machine drift and variation in instrumental sensitivity during analysis using the added 115In as well as instrument mass bias using elemental standards for Fe, Zn, Ni, Cu, Pb, and Cd. Subsequently, all counts for isotope spiked elements were converted to concentration in nmol/kg based on the weight of the sample and known concentrations of the added isotope spike mixture. The counts for the monoisotopic elements were converted to concentration units using the matrix-matched standard curves, which were run through the SeaFAST themselves as samples. It should be noted that all Cd concentrations are reported based on the 114/111Cd ratio.

For every 40 seawater samples at least 24 "Procedure blanks" were included throughout the run (every 10 seawater samples). These process blanks consisted of freshly acidified milli-Q (MQ) water spiked with a diluted version of the isotope spike mixture. Each blank was processed identically to a sample in an attempt to account for contamination coming from solutions (buffer, eluent) used or the SeaFAST itself. The MQ water is typically collected from various supplies at Texas A&M to ensure that the "procedure blank" is not derived from the MQ water itself. After conversion to concentration units, the most consistent procedure blank values for each metal are used to subtract an average procedure blank from all sample concentrations determined during that run. Each run, an internal standard was analyzed six times and an external standard (such as SAFe water) was analyzed two times as a "check" of our long-term precision and accuracy.

Quality Control:
For detection limits, accuracy, and precision information, refer to the Supplemental File Detection_Limits_Accuracy_Precision_817259 (PDF)

Quality Flags:
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 Processing:
- renamed fields;
- added date/time columns in ISO8601 format.

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Related Publications

Charette, M. A., Kipp, L. E., Jensen, L. T., Dabrowski, J. S., Whitmore, L. M., Fitzsimmons, J. N., … Bundy, R. M. (2020). The Transpolar Drift as a Source of Riverine and Shelf-Derived Trace Elements to the Central Arctic Ocean. Journal of Geophysical Research: Oceans, 125(5). doi:10.1029/2019jc015920 https://doi.org/10.1029/2019JC015920
Results

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, G., Andersson, P., Codispoti, L., Croot, P., François, R., Lohan, M. C., Obata, H. and Rutgers v. d. Loeff, M. (2010). Sampling and Sample-handling Protocols for GEOTRACES Cruises, [Miscellaneous] Version 1. http://www.geotraces.org/libraries/documents/Intercalibration/Cookbook.pdf
Methods

Fitzsimmons, J. N., & Boyle, E. A. (2012). An intercalibration between the GEOTRACES GO-FLO and the MITESS/Vanes sampling systems for dissolved iron concentration analyses (and a closer look at adsorption effects). Limnology and Oceanography: Methods, 10(6), 437–450. doi:10.4319/lom.2012.10.437
Methods

Jensen, L. T., Wyatt, N. J., Landing, W. M., & Fitzsimmons, J. N. (2020). Assessment of the stability, sorption, and exchangeability of marine dissolved and colloidal metals. Marine Chemistry, 220, 103754. doi:10.1016/j.marchem.2020.103754
Methods

Jensen, L. T., Wyatt, N. J., Twining, B. S., Rauschenberg, S., Landing, W. M., Sherrell, R. M., & Fitzsimmons, J. N. (2019). Biogeochemical Cycling of Dissolved Zinc in the Western Arctic (Arctic GEOTRACES GN01). Global Biogeochemical Cycles, 33(3), 343–369. doi:10.1029/2018gb005975 https://doi.org/10.1029/2018GB005975
Results

Jensen, Laramie T. (2020). The Biogeochemical Cycling of Dissolved and Colloidal Trace Metals in the Western Arctic Ocean. PhD Dissertation. Texas A&M University.
Results

Kadko, D., Aguilar-Islas, A., Bolt, C., Buck, C. S., Fitzsimmons, J. N., Jensen, L. T., … Anderson, R. F. (2019). The residence times of trace elements determined in the surface Arctic Ocean during the 2015 US

Arctic GEOTRACES expedition. Marine Chemistry, 208, 56–69. doi:10.1016/j.marchem.2018.10.011
Results

Lagerström, M. E., Field, M. P., Séguret, 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
Methods

Marsay, C. M., Aguilar-Islas, A., Fitzsimmons, J. N., Hatta, M., Jensen, L. T., John, S. G., … Buck, C. S. (2018). Dissolved and particulate trace elements in late summer Arctic melt ponds. Marine Chemistry, 204, 70–85. doi:10.1016/j.marchem.2018.06.002
Results

Sohrin, Y., Urushihara, S., Nakatsuka, S., Kono, T., Higo, E., Minami, T., … Umetani, S. (2008). Multielemental Determination of GEOTRACES Key Trace Metals in Seawater by ICPMS after Preconcentration Using an Ethylenediaminetriacetic Acid Chelating Resin. Analytical Chemistry, 80(16), 6267–6273. doi:10.1021/ac800500f
Methods

Zhang, R., Jensen, L. T., Fitzsimmons, J. N., Sherrell, R. M., & John, S. (2019). Dissolved cadmium and cadmium stable isotopes in the western Arctic Ocean. Geochimica et Cosmochimica Acta, 258, 258–273. doi:10.1016/j.gca.2019.05.028
Results

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Parameters

Parameter	Description	Units
Station_ID	Station number	unitless
Start_Date_UTC	Sampling start day (UTC); format: MM/DD/YYYY	unitless
Start_Time_UTC	Sampling start time (UTC); format: hh:mm	unitless
Start_ISO_DateTime_UTC	Sampling start date/time (UTC) formatted to ISO8601 standard: YYYY-MM-DDThh:mmz	unitless
End_Date_UTC	Sampling end day (UTC); format: MM/DD/YYYY	unitless
End_Time_UTC	Sampling end time (UTC); format: hh:mm	unitless
End_ISO_DateTime_UTC	Sampling end date/time (UTC) formatted to ISO8601 standard: YYYY-MM-DDThh:mmz	unitless
Start_Latitude	Sampling start latitude	decimal degrees North
Start_Longitude	Sampling start longitude	decimal degrees East
End_Latitude	Sampling end latitude	decimal degrees North

End_Longitude	Sampling end longitude	decimal degrees East
Event_ID	GEOTRACES event number	unitless
Sample_ID	GEOTRACES sample number	unitless
Sample_Depth	Sample depth	meters (m)
Fe_D_CONC_BOAT_PUMP_seyj5m	Fe concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Fe_D_CONC_BOAT_PUMP_seyj5m	One standard deviation of Fe_D_CONC_BOAT_PUMP_seyj5m	nanomoles per kilogram (nmol/kg)
Flag_Fe_D_CONC_BOAT_PUMP_seyj5m	SeaDataNet quality flag for Fe_D_CONC_BOAT_PUMP_seyj5m	None
Fe_D_CONC_BOTTLE_mbve6p	Fe concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Fe_D_CONC_BOTTLE_mbve6p	One standard deviation of Fe_D_CONC_BOTTLE_mbve6p	nanomoles per kilogram (nmol/kg)
Flag_Fe_D_CONC_BOTTLE_mbve6p	SeaDataNet quality flag for Fe_D_CONC_BOTTLE_mbve6p	None
Fe_D_CONC_MELTPOND_PUMP_aovig3	Fe concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Fe_D_CONC_MELTPOND_PUMP_aovig3	One standard deviation of Fe_D_CONC_MELTPOND_PUMP_aovig3	nanomoles per kilogram (nmol/kg)
Flag_Fe_D_CONC_MELTPOND_PUMP_aovig3	SeaDataNet quality flag for Fe_D_CONC_MELTPOND_PUMP_aovig3	None
Fe_D_CONC_SUBICE_PUMP_xw9ez2	Fe concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Fe_D_CONC_SUBICE_PUMP_xw9ez2	One standard deviation of Fe_D_CONC_SUBICE_PUMP_xw9ez2	nanomoles per kilogram (nmol/kg)
Flag_Fe_D_CONC_SUBICE_PUMP_xw9ez2	SeaDataNet quality flag for Fe_D_CONC_SUBICE_PUMP_xw9ez2	None
Zn_D_CONC_BOAT_PUMP_sr4ksq	Zn concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Zn_D_CONC_BOAT_PUMP_sr4ksq	One standard deviation of Zn_D_CONC_BOAT_PUMP_sr4ksq	nanomoles per kilogram (nmol/kg)
Flag_Zn_D_CONC_BOAT_PUMP_sr4ksq	SeaDataNet quality flag for Zn_D_CONC_BOAT_PUMP_sr4ksq	None

Zn_D_CONC_BOTTLE_duv8lf	Zn concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Zn_D_CONC_BOTTLE_duv8lf	One standard deviation of Zn_D_CONC_BOTTLE_duv8lf	nanomoles per kilogram (nmol/kg)
Flag_Zn_D_CONC_BOTTLE_duv8lf	SeaDataNet quality flag for Zn_D_CONC_BOTTLE_duv8lf	None
Zn_D_CONC_MELTPOND_PUMP_6arsth	Zn concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Zn_D_CONC_MELTPOND_PUMP_6arsth	One standard deviation of Zn_D_CONC_MELTPOND_PUMP_6arsth	nanomoles per kilogram (nmol/kg)
Flag_Zn_D_CONC_MELTPOND_PUMP_6arsth	SeaDataNet quality flag for Zn_D_CONC_MELTPOND_PUMP_6arsth	None
Zn_D_CONC_SUBICE_PUMP_iiplby	Zn concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Zn_D_CONC_SUBICE_PUMP_iiplby	One standard deviation of Zn_D_CONC_SUBICE_PUMP_iiplby	nanomoles per kilogram (nmol/kg)
Flag_Zn_D_CONC_SUBICE_PUMP_iiplby	SeaDataNet quality flag for Zn_D_CONC_SUBICE_PUMP_iiplby	None
Ni_D_CONC_BOAT_PUMP_6tq9f5	Ni concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Ni_D_CONC_BOAT_PUMP_6tq9f5	One standard deviation of Ni_D_CONC_BOAT_PUMP_6tq9f5	nanomoles per kilogram (nmol/kg)
Flag_Ni_D_CONC_BOAT_PUMP_6tq9f5	SeaDataNet quality flag for Ni_D_CONC_BOAT_PUMP_6tq9f5	None
Ni_D_CONC_BOTTLE_zb891m	Ni concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Ni_D_CONC_BOTTLE_zb891m	One standard deviation of Ni_D_CONC_BOTTLE_zb891m	nanomoles per kilogram (nmol/kg)
Flag_Ni_D_CONC_BOTTLE_zb891m	SeaDataNet quality flag for Ni_D_CONC_BOTTLE_zb891m	None
Ni_D_CONC_MELTPOND_PUMP_cjc37u	Ni concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Ni_D_CONC_MELTPOND_PUMP_cjc37u	One standard deviation of Ni_D_CONC_MELTPOND_PUMP_cjc37u	nanomoles per kilogram (nmol/kg)
Flag_Ni_D_CONC_MELTPOND_PUMP_cjc37u	SeaDataNet quality flag for Ni_D_CONC_MELTPOND_PUMP_cjc37u	None

Ni_D_CONC_SUBICE_PUMP_jwng6k	Ni concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Ni_D_CONC_SUBICE_PUMP_jwng6k	One standard deviation of Ni_D_CONC_SUBICE_PUMP_jwng6k	nanomoles per kilogram (nmol/kg)
Flag_Ni_D_CONC_SUBICE_PUMP_jwng6k	SeaDataNet quality flag for Ni_D_CONC_SUBICE_PUMP_jwng6k	None
Cu_D_CONC_BOAT_PUMP_dxalhy	Cu concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Cu_D_CONC_BOAT_PUMP_dxalhy	One standard deviation of Cu_D_CONC_BOAT_PUMP_dxalhy	nanomoles per kilogram (nmol/kg)
Flag_Cu_D_CONC_BOAT_PUMP_dxalhy	SeaDataNet quality flag for Cu_D_CONC_BOAT_PUMP_dxalhy	None
Cu_D_CONC_BOTTLE_fnh92g	Cu concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Cu_D_CONC_BOTTLE_fnh92g	One standard deviation of Cu_D_CONC_BOTTLE_fnh92g	nanomoles per kilogram (nmol/kg)
Flag_Cu_D_CONC_BOTTLE_fnh92g	SeaDataNet quality flag for Cu_D_CONC_BOTTLE_fnh92g	None
Cu_D_CONC_MELTPOND_PUMP_nrdn3k	Cu concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Cu_D_CONC_MELTPOND_PUMP_nrdn3k	One standard deviation of Cu_D_CONC_MELTPOND_PUMP_nrdn3k	nanomoles per kilogram (nmol/kg)
Flag_Cu_D_CONC_MELTPOND_PUMP_nrdn3k	SeaDataNet quality flag for Cu_D_CONC_MELTPOND_PUMP_nrdn3k	None
Cu_D_CONC_SUBICE_PUMP_nlsreh	Cu concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Cu_D_CONC_SUBICE_PUMP_nlsreh	One standard deviation of Cu_D_CONC_SUBICE_PUMP_nlsreh	nanomoles per kilogram (nmol/kg)
Flag_Cu_D_CONC_SUBICE_PUMP_nlsreh	SeaDataNet quality flag for Cu_D_CONC_SUBICE_PUMP_nlsreh	None
Cd_D_CONC_BOAT_PUMP_gn8aeu	Cu concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Cd_D_CONC_BOAT_PUMP_gn8aeu	One standard deviation of Cd_D_CONC_BOAT_PUMP_gn8aeu	nanomoles per kilogram (nmol/kg)
Flag_Cd_D_CONC_BOAT_PUMP_gn8aeu	SeaDataNet quality flag for Cd_D_CONC_BOAT_PUMP_gn8aeu	None

Cd_D_CONC_BOTTLE_q5wtaz	Cd concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Cd_D_CONC_BOTTLE_q5wtaz	One standard deviation of Cd_D_CONC_BOTTLE_q5wtaz	nanomoles per kilogram (nmol/kg)
Flag_Cd_D_CONC_BOTTLE_q5wtaz	SeaDataNet quality flag for Cd_D_CONC_BOTTLE_q5wtaz	None
Cd_D_CONC_MELTPOND_PUMP_uqcvgj	Cd concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Cd_D_CONC_MELTPOND_PUMP_uqcvgj	One standard deviation of Cd_D_CONC_MELTPOND_PUMP_uqcvgj	nanomoles per kilogram (nmol/kg)
Flag_Cd_D_CONC_MELTPOND_PUMP_uqcvgj	SeaDataNet quality flag for Cd_D_CONC_MELTPOND_PUMP_uqcvgj	None
Cd_D_CONC_SUBICE_PUMP_tsxyvz	Cd concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Cd_D_CONC_SUBICE_PUMP_tsxyvz	One standard deviation of Cd_D_CONC_SUBICE_PUMP_tsxyvz	nanomoles per kilogram (nmol/kg)
Flag_Cd_D_CONC_SUBICE_PUMP_tsxyvz	SeaDataNet quality flag for Cd_D_CONC_SUBICE_PUMP_tsxyvz	None
Pb_D_CONC_BOAT_PUMP_ivc9dz	Pb concentration; Size fraction: Dissolved,	picomoles per kilogram (pmol/kg)
SD1_Pb_D_CONC_BOAT_PUMP_ivc9dz	One standard deviation of Pb_D_CONC_BOAT_PUMP_ivc9dz	picomoles per kilogram (pmol/kg)
Flag_Pb_D_CONC_BOAT_PUMP_ivc9dz	SeaDataNet quality flag for Pb_D_CONC_BOAT_PUMP_ivc9dz	None
Pb_D_CONC_BOTTLE_4csho6	Pb concentration; Size fraction: Dissolved,	picomoles per kilogram (pmol/kg)
SD1_Pb_D_CONC_BOTTLE_4csho6	One standard deviation of Pb_D_CONC_BOTTLE_4csho6	picomoles per kilogram (pmol/kg)
Flag_Pb_D_CONC_BOTTLE_4csho6	SeaDataNet quality flag for Pb_D_CONC_BOTTLE_4csho6	None
Pb_D_CONC_MELTPOND_PUMP_bhefxy	Pb concentration; Size fraction: Dissolved,	picomoles per kilogram (pmol/kg)
SD1_Pb_D_CONC_MELTPOND_PUMP_bhefxy	One standard deviation of Pb_D_CONC_MELTPOND_PUMP_bhefxy	picomoles per kilogram (pmol/kg)
Flag_Pb_D_CONC_MELTPOND_PUMP_bhefxy	SeaDataNet quality flag for Pb_D_CONC_MELTPOND_PUMP_bhefxy	None

Pb_D_CONC_SUBICE_PUMP_g778y2	Pb concentration; Size fraction: Dissolved,	picomoles per kilogram (pmol/kg)
SD1_Pb_D_CONC_SUBICE_PUMP_g778y2	One standard deviation of Pb_D_CONC_SUBICE_PUMP_g778y2	picomoles per kilogram (pmol/kg)
Flag_Pb_D_CONC_SUBICE_PUMP_g778y2	SeaDataNet quality flag for Pb_D_CONC_SUBICE_PUMP_g778y2	None
Mn_D_CONC_BOAT_PUMP_qcoz2h	Mn concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Mn_D_CONC_BOAT_PUMP_qcoz2h	One standard deviation of Mn_D_CONC_BOAT_PUMP_qcoz2h	nanomoles per kilogram (nmol/kg)
Flag_Mn_D_CONC_BOAT_PUMP_qcoz2h	SeaDataNet quality flag for Mn_D_CONC_BOAT_PUMP_qcoz2h	None
Mn_D_CONC_BOTTLE_xxmo2v	Mn concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Mn_D_CONC_BOTTLE_xxmo2v	One standard deviation of Mn_D_CONC_BOTTLE_xxmo2v	nanomoles per kilogram (nmol/kg)
Flag_Mn_D_CONC_BOTTLE_xxmo2v	SeaDataNet quality flag for Mn_D_CONC_BOTTLE_xxmo2v	None
Mn_D_CONC_MELTPOND_PUMP_6uncit	Mn concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Mn_D_CONC_MELTPOND_PUMP_6uncit	One standard deviation of Mn_D_CONC_MELTPOND_PUMP_6uncit	nanomoles per kilogram (nmol/kg)
Flag_Mn_D_CONC_MELTPOND_PUMP_6uncit	SeaDataNet quality flag for Mn_D_CONC_MELTPOND_PUMP_6uncit	None
Mn_D_CONC_SUBICE_PUMP_1umris	Mn concentration; Size fraction: Dissolved,	nanomoles per kilogram (nmol/kg)
SD1_Mn_D_CONC_SUBICE_PUMP_1umris	One standard deviation of Mn_D_CONC_SUBICE_PUMP_1umris	nanomoles per kilogram (nmol/kg)
Flag_Mn_D_CONC_SUBICE_PUMP_1umris	SeaDataNet quality flag for Mn_D_CONC_SUBICE_PUMP_1umris	None

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Instruments

Dataset-specific Instrument Name	GO-FLO bottles
Generic Instrument Name	GO-FLO Bottle
Dataset-specific Description	All trace metal-clean seawater samples in this dataset were collected following the prescribed US GEOTRACES protocol ("GEOTRACES cookbook"). Briefly, 24 Teflon-coated, acid-cleaned and preconditioned GO-FLO bottles were deployed on an epoxy-coated aluminum rosette and were tripped on ascent at 3 m/min
Generic Instrument Description	GO-FLO bottle cast used to collect water samples for pigment, nutrient, plankton, etc. The GO-FLO sampling bottle is specially designed to avoid sample contamination at the surface, internal spring contamination, loss of sample on deck (internal seals), and exchange of water from different depths.

Dataset-specific Instrument Name	titanium trace metal coring system
Generic Instrument Name	Ice Corer
Dataset-specific Description	Ice was drilled with a polypropylene/titanium trace metal coring system.
Generic Instrument Description	An ice corer is used to drill into deep ice and remove long cylinders of ice from which information about the past and present can be inferred. Polar ice cores contain a record of the past atmosphere - temperature, precipitation, gas content, chemical composition, and other properties. This can reveal a broad spectrum of information on past environmental, and particularly climatic, changes. They can also be used to study bacteria and chlorophyll production in the waters from which the ice core was extracted.

Dataset-specific Instrument Name	SeaFAST pico, Elemental Scientific Inc.
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Samples were analyzed for trace metal (Fe, Ni, Cu, Zn, Pb, Cd, Mn) concentrations at Texas A&M University after pre-concentration on a SeaFAST-pico system (Elemental Scientific Inc.). The seaFAST-pico is an ultra-clean, inline, automated, low-pressure ion chromatography system. The automated method buffers acidified seawater inline before loading it onto a column, where matrix is removed and the concentrated sample is eluted directly to an ICP-MS.
Generic Instrument Description	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

Dataset-specific Instrument Name	Element XR high-resolution inductively coupled plasma mass spectrometer (HR-ICP-MS)
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	A Thermo Element XR high resolution ICP-MS in the Ken Williams Radiogenic Facility in the College of Geosciences at Texas A&M University was used.
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	centrifugal pump; polyethylene pump
Generic Instrument Name	Pump
Dataset-specific Description	A small subset of samples from designated "ice stations" (Stations 31, 33, 39, 43) were collected under the ice (approx. 1, 5, and 20 m) after the ice was drilled with a polypropylene/titanium trace metal coring system. Sampling was done using a polypropylene, battery-powered motor centrifugal pump with ½ inch FEP-lined Tygon tubing. At these same "ice stations", melt pond samples were collected by clearing surface snow with an acid-cleaned polyethylene shovel and then using a polyethylene/titanium trace metal coring system to drill through the upper ice. Melt pond water was pumped using a battery-powered polyethylene pump through pre-cleaned C-flex tubing into a pre-cleaned LDPE carboy.
Generic Instrument Description	A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps

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Deployments

HLY1502

Website	https://www.bco-dmo.org/deployment/638807
Platform	USCGC Healy
Report	http://dmoserv3.whoi.edu/data_docs/GEOTRACES/Arctic/ARC01-report.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).

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Project Information

U.S. Arctic GEOTRACES Study (U.S. GEOTRACES Arctic)

Coverage: Arctic Ocean; Sailing from Dutch Harbor to Dutch Harbor

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.

GEOTRACES Arctic section: Dissolved micronutrient trace metal distributions and size partitioning (Arctic GN01 Diss Metals)

Coverage: Western Arctic Ocean

NSF Award Abstract: In this project, investigators participating in the 2015 U.S. GEOTRACES Arctic expedition will measure the concentrations of iron, manganese, zinc, copper, cadmium, and nickel from a variety of seawater and ice samples in the Western Arctic Ocean. These are commonly referred to as 'micronutrients' because they are present in the ocean in extremely low concentrations and because they are essential for marine organisms. 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. The six trace elements to be measured in this study are arguably the most important bioactive trace elements in the oceans, and their measurement will provide key information on biological and physical processes in the Arctic. This project will be carried out under the direction of a postdoctoral researcher, providing a unique professional development opportunity for an early career scientist. In addition, the research will involve the training of an undergraduate researcher, and provide public outreach opportunities to K-12 teachers and students, and indigenous populations in Alaska. The six micronutrients to be measured under this project have all been identified as key trace elements for the GEOTRACES Program. This research will allow rigorous testing of the Arctic physical and biological processes, many of which are already undergoing fundamental changes as a result of climate change, that control the inputs and fate of key micronutrient metals in the Arctic Ocean. Colloidal distributions are specifically targeted in order to derive additional information on the unique physicochemical form and reactivity of distinct dissolved metal pools. The project will also explore the role of melting sea ice in driving near-surface concentrations of these elements by measuring concentrations and size partitioning of these six metals in sea ice, snow, melt ponds, and in the seawater immediately under sea ice. Given that the Arctic is a relatively small basin surrounded by broad continental shelves, sedimentary sources and sinks will also play a major role in controlling the distributions of these elements. Thus, metal concentrations in porewater samples from bottom sediments will also be determined from cores in the Bering and Chukchi Seas, in order to investigate benthic exchanges.

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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-1713677
NSF Division of Ocean Sciences (NSF OCE)	OCE-1434493

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