Concentrations and stable isotopes of total and deionized water-soluble Fe, Zn, and Cd bulk aerosols and Fe concentrations and stable isotopes of coarse and fine aerosols from Leg 2 of the US GEOTRACES PMT cruise (GP15, RR1815) from Oct to Nov 2018

Website: https://www.bco-dmo.org/dataset/937148
Data Type: Cruise Results
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Project
» US GEOTRACES Pacific Meridional Transect (GP15) (U.S. GEOTRACES PMT)
» Collaborative Research: US GEOTRACES PMT: Quantification of Atmospheric Deposition and Trace Element Fractional Solubility (PMT Aerosol Collection)
» Collaborative research: US GEOTRACES PMT: Trace-metal concentrations and stable isotopes in the North Pacific (PMT TM Stable Isotopes)

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

Contributors	Affiliation	Role
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Marsay, Christopher	Skidaway Institute of Oceanography (SkIO)	Scientist
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Abstract
This dataset reports concentrations and stable isotopes of total and deionized water-soluble iron (Fe), zinc (Zn), and cadmium (Cd) bulk aerosols and Fe concentrations and stable isotopes of coarse (>0.95 micrometers (µm)) and fine (<0.95 µm) aerosols collected durin Leg 2 (RR1815) of the US GEOTRACES GP15 Pacific Meridional Transect (PMT) cruise on R/V Roger Revelle from October to November 2018 on a meridional transect along 152°W from Alaska to Tahiti. Concentration and isotope data were collected by Zachary Bunnell, Dr. Matthias Sieber, and Dr. Tim Conway at the University of South Florida using a Thermo Neptune Plus MC-ICPMS following aerosol collection and processing by Dr. Clifton Buck's group. Trace metal isotope ratios are an important emerging tool in aerosols to trace aerosol sources of each metal. Data from Leg 1 of the cruise (RR1814) are available in a separate dataset.

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Coverage

Spatial Extent: **N**:18.752 **E**:-151.238 **S**:-20 **W**:-155.899
Temporal Extent: 2018-10-25 - 2018-11-23

Methods & Sampling

Bulk Aerosol Collection, Digestion, and Leaching Methods (reproduced from Marsay et al., 2022a (GBC vol 36, issue 2), 2022b (GBC vol 36, issue 8):
23 bulk aerosol sample collections were carried out during GP15, with an average of ~40 hours of total sampling time spread over a period of 1-4 days per deployment. Samples were collected using a high-volume aerosol sampler (~1.2 cubic meters of air per minute (m^3 air min-1); Tisch Environmental, model 5170V-BL) deployed on the forward rail of the ship's 03 deck, approximately 16 meters (m) above sea level. For each deployment, 12 replicate acid-washed 47-millimeter (mm) Whatman 41 ashless filters mounted on polypropylene filter holders (Advantec-MFS) were installed on the aerosol sampler upon a custom-built PVC adaptor plate, and an air volume averaging ~240 m^3 was sampled through each filter. To avoid contamination from the stack exhaust, sampling was restricted to periods when relative wind direction was from the front of the ship's bow and at >0.5 meters per second (m s-1) for at least two minutes, as measured by an anemometer and wind vane interfaced with the sampler through a Campbell Scientific CR800 data-logger. All loading and unloading of filter holders took place inside a plastic "bubble" constructed in the ship's main laboratory and supplied with HEPA-filtered air, and filters were handled using acid-washed tweezers. Following sample recovery, filters were stored frozen until further processing back on land.

Triplicate 47 mm filters from each deployment were treated with a three-step strong acid digestion protocol, based on that of Morton et al. (2013), in a Class-100 clean room facility at Skidaway Institute of Oceanography. Briefly, each filter was transferred to a 15 milliliter (mL) perfluoroalkoxy (PFA; Savillex) vial and sequentially digested on a hotplate at 140 degrees Celsius (°C) with: (a) 1,000 microliter (µL) concentrated double-distilled nitric acid (d-HNO3); (b) 500 µL concentrated d-HNO3 with 100 µL concentrated hydrofluoric acid (Fisher Trace Metal Grade) and 100 µL concentrated hydrogen peroxide (Fisher Optima Grade); (c) 500 µL concentrated d-HNO3. Each heating stage was conducted overnight, with samples taken to dryness on the hotplate the following day. Following the third dry-down, residues were dissolved in 0.32 M d-HNO3 for analysis. Unused W41 filters were treated in the same way as samples and average filter blank values for each element were subtracted from every sample to account for the filter matrix and digest reagent contributions. 47 mm filters for each deployment were leached with ultrapure water to provide water-soluble trace elements following the methods of Marsay et al.(2022b), as modified from Buck et al. (2006). Briefly, aerosol filters were loaded onto a Savillex PFA filtration rig on top of a purpose built vacuum chamber, with a 0.2 micrometer (µm) polycarbonate membrane backing filter. A gentle vacuum was applied and 100 mL of ultrapure water was poured over the filter, collected, and then samples were acidfied to 0.024M HCl.

Size-fractionated aerosols (reproduced from Bunnell et al., submitted to GRL):
Size-fractionated aerosol samples were collected on five Whatman 41 cellulose ester stage filters and one Whatman 41 cellulose ester backing filter during 12 deployments using a Tisch Environmental, Inc High Volume Cascade Multi-Stage Particulate Size Fractionator Impactor (Series 230) set to collect 1.2 m^3 air per minute (Tisch Environmental, Inc, 2004; Gurganus et al., 2015). The impactors collect the size-fractionated aerosols onto one of five stage filters or backing filter. Exact size partitioning of each size filter requires additional analytical techniques outside the scope of this work, but the size cut offs for each stage can be estimated as: stage one (>7.2 µm), stage two (3.0-7.2 µm), stage three (1.5-3.0 µm), stage four (0.95-1.5 µm), stage five (0.49-0.95 µm), and backing filter (<0.49 µm) (Tisch Environmental, Inc, 2004; Gurganus et al., 2015). Stage and backing filters were cut into nine (stage 1) or ten (stages 2-5 and backing filter) strips using a ceramic knife and were processed in the same manner as bulk aerosol digests (Marsay et al., 2022a). Briefly, two stage filter strips (one for backing filter) were digested in a series of HNO3, HF-HNO3-H2O2, and HNO3 overnight dry-downs heated to 140oC in a Teflon beaker. After digestion, the samples were dried down before being redissolved in 13 mL of 2% HNO3.

Analysis for Fe, Zn, and Cd trace metals and stable isotope ratios:
Sample aliquots of a subset of digested aerosol laden GP15 filters (bulk or size-fractionated), or DI-water leachates were provided for analysis at the University of South Florida. Digests and DIW leaches were measured for Fe, Zn, and Cd stable isotopes and concentrations. Size fractionated samples were measured for Fe isotopes and concentrations - following MC-ICPMS measurement (see below), size-fractionated samples were binned according to filter stage (size). Data for coarse (filters >0.95 µm) and fine (<0.95 µm) aerosol size-fractions were calculated and reported here to match GEOTRACES parameters.

Samples were processed for dissolved Fe, Zn and Cd isotope and concentration analysis at the University of South Florida following Sieber et al. (2019), modified from Conway et al. (2013) and Conway et al. (2019). For all samples Fe, Zn, and Cd double spikes were added prior to chemical processing, in an approximate 1:2 sample:spike ratio based on expected concentrations from other analysis. Total digested aliquots were then evaporated to dryness, while leached samples were put through a batch extraction using Nobias PA-1 chelating resin and evaporated to dryness. All samples were then refluxed with a HNO3-H2O2 solution to digest organics, followed by purification by anion-exchange chromatography using AG-MP1 resin. Isotope analyses were then performed on a Thermo Neptune Plus MC-ICPMS in the Tampa Bay Plasma Facility at the University of South Florida using the double spike technique via a ~100 uL min-1 PFA nebulizer and Apex Ω (Fe, Zn) or Apex Q (Cd) introduction introduction system, Pt Jet (Fe, Cd) or Ni H (Zn)

Sampler cone and an Al X (Fe) or Ni H (Cd, Zn) skimmer cone (Sieber et al., 2021; Sieber et al., 2023a; 2023b).

We express Cd stable isotope ratios in delta notation (δ114Cd) relative to the NIST SRM-3108 Cd standard. A secondary standard, BAM-I012, was analyzed over 8 sessions on the same timescale as the samples to provide an estimate of long-term instrumental precision. We obtain a value of −1.32 ± 0.06‰ (2SD, n = 172), in agreement with consensus values (Abouchami et al., 2013). We consider a 2SD uncertainty of 0.06‰ as a conservative estimate of analytical precision, and have applied it to all samples, except for low concentration samples where the larger internal error is considered a more conservative estimate of uncertainty. Concentrations were calculated using the isotope dilution technique based on on-peak blank, interference and mass-bias corrected 114Cd/111Cd ratios measured simultaneously with isotope analyses (Sieber et al., 2019). We express uncertainty (1SD) on Cd concentrations as 2% (Conway et al., 2013).

We express Fe stable isotope ratios in delta notation (δ56Fe) relative to the IRMM-014 standard. A secondary Fe standard, NIST-3126, was analyzed over 44 sessions to provide an estimate of long-term instrumental precision. We obtain a value of +0.36 ± 0.05‰ (2SD, n = 604), in agreement with consensus values (Conway et al., 2013). We consider a 2SD uncertainty of 0.05‰ as an estimate of analytical precision, and have applied it to all samples, except for low concentration samples where the larger internal error is considered a more conservative estimate of uncertainty. Concentrations were calculated using the isotope dilution technique based on on-peak blank, interference and mass-bias corrected 57Fe/56Fe ratios measured simultaneously with isotope analysis. We express uncertainty (1SD) on Cd concentrations as 2% (Conway et al., 2013).

We express Zn stable isotope ratios in delta notation (δ66Zn) relative to the JMC-Lyon standard. A secondary Zn standard, AA-ETH, was analyzed on the same timescale as the samples (over 10 sessions) to provide an estimate of long-term instrumental precision. We obtain a value of +0.28 ± 0.03‰ (2SD, n = 147), in agreement with consensus values (Archer et al., 2017). As a second estimate of external precision, we use the 2SD of offsets from the mean of full replicate measurements based on 26 pairs of replicate analysis using separate seawater samples collected at the same depth (0.03‰), which is similar to the analytical precision. Therefore, we consider a 2SD uncertainty of 0.03‰ as an estimate of analytical precision, and have applied it to all samples, except for low concentration samples where the larger internal error is considered a more conservative estimate of uncertainty. Concentrations were calculated using the isotope dilution technique based on on-peak blank, interference and mass-bias corrected 67Zn/66Zn ratios measured simultaneously with isotope analysis. We express uncertainty (1SD) on Zn concentrations as 5%, based on replicate analysis on separate seawater samples collected at the same depth (n = 26).

Fe stable isotope ratios are expressed in delta notation (δ56Fe) relative to the IRMM-014 standard. A secondary Fe standard, NIST-3126, was analyzed over 44 sessions to provide an estimate of long-term instrumental precision. We obtain a value of +0.36 ± 0.05‰ (2SD, n = 524; runs = 37), in agreement with consensus values (Hunt et al. 2022; Conway et al., 2013). We consider a 2SD uncertainty of 0.05‰ as an estimate of analytical precision, and have applied it to all samples, except for low concentration samples where the larger internal error is considered a more conservative estimate of uncertainty.

Data Processing Description

Sample data were blank corrected based on the isotopic signature and concentration of replicate filter blanks for each element (Bunnell et al., submitted to GRL).

Data were processed in Microsoft Excel using an-in house double spike reduction scheme from Sieber et al. (2021), based on Siebert et al. (2001).

BCO-DMO Curation Notes

- Imported original file "RR1815_dataTemplate.xlsx" into the BCO-DMO system.
- Renamed fields to comply with BCO-DMO naming conventions.
- Created date and time fields in ISO 8601 format.
- Converted positive longitude values to negative.
- Removed empty columns: Gear_ID, Sample_Depth.
- Saved the final file as "937148_v1_gp15_soluble_aerosol_fe_zn_cd_isotopes_leg2.csv".

Problem Description

Data are assigned quality flags according to GEOTRACES Flag Policy (https://www.geotraces.org/geotraces-quality-flag-policy/); obvious outliers are marked as 4, missing data as 9, all good data as 2.

No data are reported for total aerosol δ114Cd due to prohibitive levels of Sn compromising accuracy during MC-ICPMS measurement.

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Data Files

File	
937148_v1_gp15_soluble_aerosol_fe_zn_cd_isotopes_leg2.csv	(Comma Separated Values (.csv), 4.45 KB) MD5:d172668de0da4c7fffe089c798dc1618
Primary data file for dataset ID 937148, version 1	

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Related Publications

Abouchami, W., Galer, S. J. G., Horner, T. J., Rehkämper, M., Wombacher, F., Xue, Z., Lambelet, M., Gault-Ringold, M., Stirling, C. H., Schönbächler, M., Shiel, A. E., Weis, D., & Holdship, P. F. (2012). A Common Reference Material for Cadmium Isotope Studies - NIST SRM 3108. Geostandards and Geoanalytical Research, 37(1), 5–17. https://doi.org/10.1111/j.1751-908x.2012.00175.x
Methods

Buck, C. S., Landing, W. M., Resing, J. A., & Lebon, G. T. (2006). Aerosol iron and aluminum solubility in the northwest Pacific Ocean: Results from the 2002 IOC cruise. Geochemistry, Geophysics, Geosystems, 7(4), n/a–n/a. doi:10.1029/2005gc000977
Methods

Conway, T. M., Hamilton, D. S., Shelley, R. U., Aguilar-Islas, A. M., Landing, W. M., Mahowald, N. M., & John, S. G. (2019). Tracing and constraining anthropogenic aerosol iron fluxes to the North Atlantic Ocean using iron isotopes. Nature Communications, 10(1). https://doi.org/10.1038/s41467-019-10457-w
Methods

Conway, T. M., Rosenberg, A. D., Adkins, J. F., & John, S. G. (2013). A new method for precise determination of iron, zinc and cadmium stable isotope ratios in seawater by double-spike mass spectrometry. Analytica Chimica Acta, 793, 44–52. doi:10.1016/j.aca.2013.07.025
Methods

Gurganus, S. C., Wozniak, A. S., & Hatcher, P. G. (2015). Molecular characteristics of the water soluble organic matter in size-fractionated aerosols collected over the North Atlantic Ocean. Marine Chemistry, 170, 37–48. https://doi.org/10.1016/j.marchem.2015.01.007
Methods

Hunt, H. R., Summers, B. A., Sieber, M., Krisch, S., Al-Hashem, A., Hopwood, M., Achterberg, E. P., & Conway, T. M. (2022). Distinguishing the influence of sediments, the Congo River, and water-mass mixing on the distribution of iron and its isotopes in the Southeast Atlantic Ocean. Marine Chemistry, 247, 104181. https://doi.org/10.1016/j.marchem.2022.104181
Methods

Marsay, C. M., Kadko, D., Landing, W. M., & Buck, C. S. (2022). Bulk Aerosol Trace Element Concentrations and Deposition Fluxes During the U.S. GEOTRACES GP15 Pacific Meridional Transect. Global Biogeochemical Cycles, 36(2). Portico. https://doi.org/10.1029/2021gb007122
Methods

Marsay, C. M., Landing, W. M., Umstead, D., Till, C. P., Freiberger, R., Fitzsimmons, J. N., Lanning, N. T., Shiller, A. M., Hatta, M., Chmiel, R., Saito, M., & Buck, C. S. (2022). Does Sea Spray Aerosol Contribute Significantly to Aerosol Trace Element Loading? A Case Study From the U.S. GEOTRACES Pacific Meridional Transect (GP15). Global Biogeochemical Cycles, 36(8). Portico. https://doi.org/10.1029/2022gb007416
Methods

Morton, P. L., Landing, W. M., Hsu, S.-C., Milne, A., Aguilar-Islas, A. M., Baker, A. R., … Zamora, L. M. (2013). Methods for the sampling and analysis of marine aerosols: results from the 2008 GEOTRACES aerosol intercalibration experiment. Limnology and Oceanography: Methods, 11(2), 62–78. doi:10.4319/lom.2013.11.62
Methods

Sieber, M., Conway, T. M., de Souza, G. F., Hassler, C. S., Ellwood, M. J., & Vance, D. (2021). Isotopic fingerprinting of biogeochemical processes and iron sources in the iron-limited surface Southern Ocean. Earth and Planetary Science Letters, 567, 116967. https://doi.org/10.1016/j.epsl.2021.116967
Methods

Sieber, M., Conway, T. M., de Souza, G. F., Obata, H., Takano, S., Sohrin, Y., & Vance, D. (2019). Physical and biogeochemical controls on the distribution of dissolved cadmium and its isotopes in the Southwest Pacific Ocean. Chemical Geology, 511, 494–509. doi:10.1016/j.chemgeo.2018.07.021
Methods

Sieber, M., Lanning, N. T., Bian, X., Yang, S. -C., Takano, S., Sohrin, Y., Weber, T. S., Fitzsimmons, J. N., John, S. G., & Conway, T. M. (2023). The Importance of Reversible Scavenging for the Marine Zn Cycle Evidenced by the Distribution of Zinc and Its Isotopes in the Pacific Ocean. Journal of Geophysical Research: Oceans, 128(4). Portico. https://doi.org/10.1029/2022jc019419
Methods

Sieber, M., Lanning, N. T., Bunnell, Z. B., Bian, X., Yang, S., Marsay, C. M., Landing, W. M., Buck, C. S., Fitzsimmons, J. N., John, S. G., & Conway, T. M. (2023). Biological, Physical, and Atmospheric Controls on the Distribution of Cadmium and Its Isotopes in the Pacific Ocean. Global Biogeochemical Cycles, 37(2). Portico. https://doi.org/10.1029/2022gb007441
Results

Siebert, C., Nägler, T. F., & Kramers, J. D. (2001). Determination of molybdenum isotope fractionation by double-spike multicollector inductively coupled plasma mass spectrometry. Geochemistry, Geophysics, Geosystems, 2(7), n/a–n/a. doi:10.1029/2000gc000124
Methods

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Related Datasets

Continues

Conway, T. M., Buck, C. S., John, S. G., Landing, W. M., Marsay, C. (2024) **Concentrations and stable isotopes of total and deionized water-soluble Fe, Zn, and Cd bulk aerosols and Fe concentrations and stable isotopes of coarse and fine aerosols from Leg 1 of the US GEOTRACES PMT cruise (GP15, RR1814) from Sept to Oct 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-09-23 doi:10.26008/1912/bco-dmo.937120.1 [view at BCO-DMO]
Relationship Description: GP15 was made up of two cruise legs, RR1814 (Leg 1) and RR1815 (Leg 2)

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Parameters

Parameter	Description	Units
Station_ID	Sampling station ID	unitless
Event_ID	Event number	unitless
Start_Date_UTC	Date at start of sampling	unitless
Start_Time_UTC	Time (UTC) at start of sampling	unitless
Start_ISO_DateTime_UTC	Date and time (UTC) at start of sampling in ISO 8601 format	unitless
End_Date_UTC	Date at end of sampling	unitless
End_Time_UTC	Time (UTC) at end of sampling	unitless

End_ISO_DateTime_UTC	Date and time (UTC) at end of sampling in ISO 8601 format	unitless
Start_Latitude	Latitude at start of sampling	decimal degrees North
Start_Longitude	Longitude at start of sampling	decimal degrees East
End_Latitude	Latitude at end of sampling	decimal degrees North
End_Longitude	Longitude at end of sampling	decimal degrees East
Rosette_Position	Aerosol sampler position	unitless
Sample_ID	GEOTRACES sample ID number	unitless
Fe_56_54_A_SMLH2O_DELTA_HIVOL_f0qtdh	Atom ratio of soluble Fe isotopes in aerosols after a very mild leaching (ultrapure water) expressed in conventional DELTA notation referenced to {IRMM-14}	per mil
SE2_Fe_56_54_A_SMLH2O_DELTA_HIVOL_f0qtdh	Uncertainty for Fe_56_54_A_SMLH2O_DELTA_HIVOL_f0qtdh	per mil
Flag_Fe_56_54_A_SMLH2O_DELTA_HIVOL_f0qtdh	Quality flag for Fe_56_54_A_SMLH2O_DELTA_HIVOL_f0qtdh	unitless
Cd_114_110_A_SMLH2O_DELTA_HIVOL_w0ytwa	Atom ratio of soluble Cd isotopes in aerosols after a very mild leaching (ultrapure water) expressed in conventional DELTA notation referenced to {NIST3108}	per mil
SE2_Cd_114_110_A_SMLH2O_DELTA_HIVOL_w0ytwa	Uncertainty for Cd_114_110_A_SMLH2O_DELTA_HIVOL_w0ytwa	per mil
Flag_Cd_114_110_A_SMLH2O_DELTA_HIVOL_w0ytwa	Quality flag for Cd_114_110_A_SMLH2O_DELTA_HIVOL_w0ytwa	unitless
Fe_56_54_A_T_DELTA_HIVOL_ppwfuf	Atom ratio of total Fe isotopes in aerosols (no preliminary leaching) expressed in conventional DELTA notation referenced to {IRMM-14}	per mil
SD1_Fe_56_54_A_T_DELTA_HIVOL_ppwfuf	Uncertainty for Fe_56_54_A_T_DELTA_HIVOL_ppwfuf	per mil

Flag_Fe_56_54_A_T_DELTA_HIVOL_ppwfuf	Quality flag for Fe_56_54_A_T_DELTA_HIVOL_ppwfuf	unitless
Fe_56_54_A_T_DELTA_COARSE_IMPACTOR_gsghig	Larger size fraction atom ratio of total Fe isotopes in aerosols (no preliminary leaching) expressed in conventional DELTA notation referenced to {IRMM-14}	per mil
SE2_Fe_56_54_A_T_DELTA_COARSE_IMPACTOR_gsghig	Uncertainty for Fe_56_54_A_T_DELTA_COARSE_IMPACTOR_gsghig	per mil
Flag_Fe_56_54_A_T_DELTA_COARSE_IMPACTOR_gsghig	Quality flag for Fe_56_54_A_T_DELTA_COARSE_IMPACTOR_gsghig	unitless
Zn_66_64_A_T_DELTA_HIVOL_mtvwtd	Atom ratio of total Zn isotopes in aerosols (no preliminary leaching) expressed in conventional DELTA notation referenced to {Lyon-JMC}	per mil
SE2_Zn_66_64_A_T_DELTA_HIVOL_mtvwtd	Uncertainty for Zn_66_64_A_T_DELTA_HIVOL_mtvwtd	per mil
Flag_Zn_66_64_A_T_DELTA_HIVOL_mtvwtd	Quality flag for Zn_66_64_A_T_DELTA_HIVOL_mtvwtd	unitless
Fe_A_T_CONC_FINE_IMPACTOR_ag5djz	Smaller size fraction of total Fe concentration in aerosols (no preliminary leaching) collected with size fractionation	picomoles per cubic meter (pmol/m^3)
SD1_Fe_A_T_CONC_FINE_IMPACTOR_ag5djz	Uncertainty for Fe_A_T_CONC_FINE_IMPACTOR_ag5djz	picomoles per cubic meter (pmol/m^3)
Flag_Fe_A_T_CONC_FINE_IMPACTOR_ag5djz	Quality flag for Fe_A_T_CONC_FINE_IMPACTOR_ag5djz	unitless
Cd_A_SMLH2O_CONC_HIVOL_0lcntj	Soluble Cd concentration in aerosols after a very mild leaching (ultrapure water)	picomoles per cubic meter (pmol/m^3)
SD1_Cd_A_SMLH2O_CONC_HIVOL_0lcntj	Uncertainty for Cd_A_SMLH2O_CONC_HIVOL_0lcntj	picomoles per cubic meter (pmol/m^3)
Flag_Cd_A_SMLH2O_CONC_HIVOL_0lcntj	Quality flag for Cd_A_SMLH2O_CONC_HIVOL_0lcntj	unitless
Fe_A_T_CONC_HIVOL_sgkomp	Total Fe concentration in aerosols (no preliminary leaching)	picomoles per cubic meter (pmol/m^3)

SD1_Fe_A_T_CONC_HIVOL_sgkomp	Uncertainty for Fe_A_T_CONC_HIVOL_sgkomp	picomoles per cubic meter (pmol/m^3)
Flag_Fe_A_T_CONC_HIVOL_sgkomp	Quality flag for Fe_A_T_CONC_HIVOL_sgkomp	unitless
Cd_A_T_CONC_HIVOL_7hqjdv	Total Cd concentration in aerosols (no preliminary leaching)	picomoles per cubic meter (pmol/m^3)
SD1_Cd_A_T_CONC_HIVOL_7hqjdv	Uncertainty for Cd_A_T_CONC_HIVOL_7hqjdv	picomoles per cubic meter (pmol/m^3)
Flag_Cd_A_T_CONC_HIVOL_7hqjdv	Quality flag forCd_A_T_CONC_HIVOL_7hqjdv	unitless
Zn_A_T_CONC_HIVOL_bpywld	Total Zn concentration in aerosols (no preliminary leaching)	picomoles per cubic meter (pmol/m^3)
SD1_Zn_A_T_CONC_HIVOL_bpywld	Uncertainty for Zn_A_T_CONC_HIVOL_bpywld	picomoles per cubic meter (pmol/m^3)
Flag_Zn_A_T_CONC_HIVOL_bpywld	Quality flag forZn_A_T_CONC_HIVOL_bpywld	unitless
Zn_A_SMLH2O_CONC_HIVOL_sbag32	Soluble Zn concentration in aerosols after a very mild leaching (ultrapure water)	picomoles per cubic meter (pmol/m^3)
SD1_Zn_A_SMLH2O_CONC_HIVOL_sbag32	Uncertainty for Zn_A_SMLH2O_CONC_HIVOL_sbag32	picomoles per cubic meter (pmol/m^3)
Flag_Zn_A_SMLH2O_CONC_HIVOL_sbag32	Quality flag for Zn_A_SMLH2O_CONC_HIVOL_sbag32	unitless
Fe_A_SMLH2O_CONC_HIVOL_mskevc	Soluble Fe concentration in aerosols after a very mild leaching (ultrapure water)	picomoles per cubic meter (pmol/m^3)
SD1_Fe_A_SMLH2O_CONC_HIVOL_mskevc	Uncertainty for Fe_A_SMLH2O_CONC_HIVOL_mskevc	picomoles per cubic meter (pmol/m^3)
Flag_Fe_A_SMLH2O_CONC_HIVOL_mskevc	Quality flag for Fe_A_SMLH2O_CONC_HIVOL_mskevc	unitless
Zn_66_64_A_SMLH2O_DELTA_HIVOL_1mxrdz	Atom ratio of soluble Zn isotopes in aerosols after a very mild leaching (ultrapure water) expressed in conventional DELTA notation referenced to {Lyon-JMC}	per mil

SE2_Zn_66_64_A_SMLH2O_DELTA_HIVOL_1mxrdz	Uncertainty for Zn_66_64_A_SMLH2O_DELTA_HIVOL_1mxrdz	per mil
Flag_Zn_66_64_A_SMLH2O_DELTA_HIVOL_1mxrdz	Quality flag for Zn_66_64_A_SMLH2O_DELTA_HIVOL_1mxrdz	unitless
Fe_A_T_CONC_COARSE_IMPACTOR_2rri2v	Larger size fraction of total Fe concentration in aerosols (no preliminary leaching) collected with size fractionation	picomoles per cubic meter (pmol/m^3)
SD1_Fe_A_T_CONC_COARSE_IMPACTOR_2rri2v	Uncertainty for Fe_A_T_CONC_COARSE_IMPACTOR_2rri2v	picomoles per cubic meter (pmol/m^3)
Flag_Fe_A_T_CONC_COARSE_IMPACTOR_2rri2v	Quality flag for Fe_A_T_CONC_COARSE_IMPACTOR_2rri2v	unitless
Fe_56_54_A_T_DELTA_FINE_IMPACTOR_qa56fn	Smaller size fraction atom ratio of total Fe isotopes in aerosols (no preliminary leaching) expressed in conventional DELTA notation referenced to {IRMM-14}	per mil
SD1_Fe_56_54_A_T_DELTA_FINE_IMPACTOR_qa56fn	Uncertainty for Fe_56_54_A_T_DELTA_FINE_IMPACTOR_qa56fn	per mil
Flag_Fe_56_54_A_T_DELTA_FINE_IMPACTOR_qa56fn	Quality flag for Fe_56_54_A_T_DELTA_FINE_IMPACTOR_qa56fn	unitless

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Instruments

Dataset-specific Instrument Name	High-volume aerosol sampler (Tisch Environmental, model 5170V-BL)
Generic Instrument Name	Aerosol Sampler
Generic Instrument Description	A device that collects a sample of aerosol (dry particles or liquid droplets) from the atmosphere.

Dataset-specific Instrument Name	Tisch Environmental, Inc High Volume Cascade Multi-Stage Particulate Size Fractionator Impactor (Series 230)
Generic Instrument Name	cascade impactor
Generic Instrument Description	A cascade impactor measures the reach range of a particulate substance as it moves through an opening with the use of aerosol. In addition to measuring the range of substances moved through an opening by aerosol, the impactor can also be used to determine the particle size of the distributed substance. The Tisch Environmental, Inc. High Volume Cascade Multi-Stage Particulate Size Fractionator Impactor (Series 230) is one example of such a device.

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

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Deployments

RR1815

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

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Project Information

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

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

Coverage: Pacific Meridional Transect along 152W (GP15)

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

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

support the personnel needed to lead the expedition and collect the samples.

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

Collaborative Research: US GEOTRACES PMT: Quantification of Atmospheric Deposition and Trace Element Fractional Solubility (PMT Aerosol Collection)

Coverage: Pacific Ocean along 152 W

NSF Award Abstract:
The goal of the international GEOTRACES program is to understand the distributions of trace chemical elements and their isotopes in the oceans. An essential part of this effort is determining the sources of trace elements to the oceans, one of which is from the atmosphere: dust falling from the air, and rain, both deliver elements to the sea surface. This project would collect and analyze samples of rainwater and of particles from the atmosphere, along a U.S. GEOTRACES expedition from Alaska to Tahiti in the fall of 2018. The timing of the expedition corresponds to the part of the year with the highest atmospheric dust concentrations in the Gulf of Alaska and may also capture the tail end of peak fire season in Asia. In contrast, the southern end of the proposed ship track is known to have very low atmospheric dust. Aerosols will be influenced by human activity in Asia as well. The anticipated differences in atmospheric deposition along the ship track will allow the assessment of the role of this process on trace element and isotope cycling. The project will support a postdoctoral investigator. The relevance of ocean-atmosphere studies to the public will be communicated at campus open house events and in online forums in collaboration with the GEOTRACES management team.

In alignment with the mission of GEOTRACES, the proposed research will address the following biogeochemical and oceanographic questions: 1) What is the magnitude of atmospheric aerosol deposition (wet and dry) to the surface of the Pacific Ocean? 2) What is the chemical composition of these aerosols and how does composition vary based on source (e.g. Alaskan glacial flour, Asian mineral dust, emissions from biomass burning, anthropogenic emissions)? 3) What is the fractional solubility of trace elements in Pacific aerosols and does solubility vary based on aerosol source? 4) What is the potential bioavailability of soluble aerosol Fe? 5) How is the soluble fraction of aerosol trace elements distributed across operationally defined size classes? 6) How does atmospheric deposition impact distributions of other GEOTRACES parameters? Atmospheric aerosol and precipitation samples will be collected over the 70-day expedition and the investigators will provide sub-samples to collaborators and other interested scientists. These samples will be analyzed for a suite of key trace elements from bulk and size-fractionated aerosol samples, aerosol leachates, and rain samples. A sequential extraction scheme designed to solubilize aerosol Fe as a function of its FeOx morphology and particle size will be used on selected samples because an understanding of aerosol trace element fractional solubility is fundamental to future work to assess the bioavailability of aerosol derived trace elements. The proposed work will provide data that directly contribute to the GEOTRACES objectives related to atmospheric deposition and will help to address temporal variability as this cruise section follows the CLIVAR/Repeat Hydrography P16N line.

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.

Collaborative research: US GEOTRACES PMT: Trace-metal concentrations and stable isotopes in the North Pacific (PMT TM Stable Isotopes)

Coverage: North Pacific

NSF Award Abstract:
The goal of the international GEOTRACES program is to understand the distributions of many chemical elements and their isotopes in the oceans. The National Science Foundation is supporting a U.S. GEOTRACES sampling expedition in the Pacific Ocean 2018, from Alaska to Tahiti. This award will focus on measurement of the stable isotopes of iron (Fe), nickel (Ni), zinc (Zn), copper (Cu), and cadmium (Cd) in seawater, filtered particles, and atmospheric aerosol particles on this expedition. The trace metals Fe, Ni, Zn, Cu, and Cd strongly influence marine biogeochemistry and carbon cycling. Measurements of isotope ratios -- the relative abundance of different forms of the same chemical element -- provide insights not possible from concentration measurements alone. The investigators will use isotope data to learn more about the inputs and outputs of these elements to the ocean as well as the biological processes that influence their distributions within the oceans, leading to greater understanding of the role these metals play in oceanic carbon cycling. The award will also host an international inter-lab comparison exercise for Cd isotope ratios at low concentrations in seawater. The project will support an early career investigator, a postdoctoral researcher, and undergraduate and graduate students.

The investigators will measure delta-56Fe, delta-60Ni, delta-65Cu, delta-66Zn, and delta-114Cd at high spatial resolution along the U.S. GEOTRACES Pacific Meridional Transect (PMT). The resulting oceanic sections of all five isotope systems will enable them to distinguish between competing ideas about the controls on trace metal distributions. A wide variety of hypotheses about marine biogeochemical trace metal cycling, addressing topics of global importance will be explored and tested, including: 1) How do different sources, productivity and export regimes, coupled with overturning circulation, control the distribution of Fe, Ni, Zn, Cu and Cd and their isotopes in the Pacific? 2) Do oxygen minimum zones act as sinks for Cd, Zn, Cu and Ni, while acting as sources for Fe? and 3) What sources are most important for supplying Fe to the North Pacific Ocean? The PMT section crosses two high nutrient-low chlorophyll (HNLC) regions and two oligotrophic gyres, as well as transecting the oldest waters in the ocean, allowing the investigators to use high-resolution isotope datasets to investigate competing hypotheses about the effect of vertical, horizontal and in situ biogeochemical processes on the distribution of all five metals and their isotopes. Aerosol dust, volcanogenic and reducing margin sediments, and hydrothermal vents such as the East Pacific Rise have all been hypothesized as major contributors to the dissolved Fe cycle in the Pacific. Measurement of iron isotope signatures in aerosols and near to oceanic sources will enable the identification and quantification the importance of these different iron sources and processes in supplying iron to the iron-limited surface ocean, especially important for the two HNLC regions along the PMT section.

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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-1756103
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756104
NSF Division of Ocean Sciences (NSF OCE)	OCE-1737136
NSF Division of Ocean Sciences (NSF OCE)	OCE-1736896

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