

Trace element concentrations in particles from R/V Knorr KN199-04, KN204-01 in the subtropical North Atlantic Ocean from 2010-2011 (U.S. GEOTRACES NAT project)

Website: <https://www.bco-dmo.org/dataset/3841>

Data Type: Cruise Results

Version: 10 March 2014

Version Date: 2014-03-10

Project

» [U.S. GEOTRACES North Atlantic Transect \(GA03\)](#) (U.S. GEOTRACES NAT)

Program

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

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Dataset Description

Trace element concentrations in particles collected with GO-Flo bottles (GT10 and GT11) and analyzed with inductively-coupled plasma mass spectrometry (ICP-MS). Concentrations of labile, refractory, and total metal fractions are reported.

Trace element quotas measured in plankton cells with single-cell synchrotron x-ray fluorescence (SXRF) analysis. Total concentrations of cellular metals are reported normalized to cellular P.

Please note that data may not be final, pending intercalibration results and further analysis. If you are interested in following changes to US GEOTRACES data, there is an RSS feed available from the [GEOTRACES-NAT](#) project page.

Methods & Sampling

Samples were collected from sub-surface waters using the GEOTRACES GO-Flo rosette. The filtration was performed directly from pressured GO-Flo bottles onto membranes (25-mm diameter Supor 0.45- μ m polyethersulfone) mounted in Swinnex polypropylene filter holders. Filters were cleaned following the protocol outlined in the GEOTRACES Sampling Document (Cutter et al. 2010). Pressurization to <8 psi was achieved with 0.2- μ m filtered air. Prior to filtration each GO-Flo bottle was gently mixed by manually inverting the bottle several times (after removal of unfiltered salt samples to provide some headspace). Filtration was continued until the entire bottle was empty or 2 hours had elapsed. An average of 6.5-L of water was filtered through

each membrane. Filter holders were removed from the GO-Flo bottles and a vacuum applied to remove any residual water. Filters were then folded, stored in acid-washed centrifuge tubes, and frozen at -20°C until digestion and analysis.

Filters were digested in rigorously cleaned 22-mL PFA digestion vials (Savillex). All digestion steps were performed in a Class-100 clean room using standard clean techniques. A subset of filters collected from the shallowest GO-Flo bottle and the deep chlorophyll maximum bottle were first digested in a solution of 25% Optima-grade acetic acid and 0.02 M hydroxylamine hydrochloride following the protocol of Berger et al. (2008). One milliliter of this solution was added to the filter stored in a 1.7-mL polypropylene vial. Following the recommendation of Berger et al. (2008), the solution was heated to 95°C in a water bath for 10 minutes and then allowed to cool to room temperature. The filter was in contact with the acetic acid leach for a total of two hours. The filter was removed to an acid-cleaned PFA bomb and was later digested using the mixture of concentrated acids described below to recover the refractory elements. The acetic acid/hydroxylamine leachate was centrifuged at 14,000 rpm for 10 minutes to sediment all particles. Without disturbing particles on the bottom of the tube, approximately 0.8-mL of leachate was transferred into a 7-mL PFA digestion vial. Optima-grade HNO₃ was added (100 µL) to the 7-mL digestion vial, which was subsequently heated uncapped at 110°C to near dryness. Vial contents were redissolved with 2% HNO₃ (Optima grade).

The refractory fraction of particulate metals was then measured on the sample filters. The filter (and any remaining leachate) was transferred to a 22-mL PFA vial, 2-mL of a mixture of 4M HCl, 4M HNO₃, and 4M HF (all Optima grade) was added, and the vial was tightly capped and heated to 110°C for 4 hours. This procedure has been determined to be adequate for digestion of all particulate material, while allowing the Supor filter to remain intact (Twining, P. Lam, P. Morton et al., unpublished). Following heating, the acid solution in the bomb was poured into a second PFA vial. To ensure complete transfer of acid, the bombs were thoroughly rinsed with 3 × 0.5-mL aliquots of ultrapure water. This water was also poured into the secondary vial. The secondary vial was then heated to dryness and the contents redissolved with 2-mL of a 50% Optima-grade HNO₃ + 15% Optima-grade H₂O₂ solution. This solution was again dried down and the contents redissolved with 2% HNO₃.

Filter samples from depths outside of the shallowest bottle and deep chlorophyll maximum bottle were digested only in the HCl/HNO₃/HF solution to provide just a 'total' particulate metal fraction.

All digests were analyzed using a Finnegan-MAT Element2 HR-ICP-MS at the University of Maine following the protocols outlined in Twining et al. (2011). The instrument is equipped with an ESI Apex desolvation nebulizer, an autosampler contained under a HEPA filter, and nickel cones. Cd-111 and Mo-98 were analyzed in low-resolution mode, and the remaining isotopes were analyzed in medium-resolution mode. Multiple isotopes were analyzed for some elements (Fe-56, Fe-57, Zn-66, Zn-68). Concentrations were within 4%, on average, for both Fe isotopes and within 10%, on average, for both Zn isotopes. Concentrations of Fe-56 and Zn-66 are reported here. Quantification was performed by standard addition, and In-115 was used as an internal standard to correct for variations in instrumental sensitivity during analyses.

Digestions of the certified reference materials BCR-414 (plankton, Community Bureau of Reference, Commission of the European Communities) and PACS-2 (marine sediment, National Research Council of Canada) were done alongside sample digestions in order to assess accuracy. Recoveries were typically within 10% of the certified values (and within the error of the data, taken from replicate measurements).

Precision was determined through replicate analyses of digests of three different particle-laden filters collected by Dr. Phoebe Lam (WHOI). These filters were distributed to US GEOTRACES investigators working on particulate trace element analyses. Each filter was digested, and the digestion solutions were separately diluted and analyzed during analytical runs in February, November and December 2012 and July 2013. Coefficients of variation (CV) were calculated from the four analyses for each element, and the results are shown in the 'precision' sheet of the attached Excel workbook. Mean precision was generally 10-15% for most elements.

SXRF samples were prepared from unfiltered water taken from GEOTRACES GO-Flo bottles at the shallowest depth and deep chlorophyll maximum. Cells were preserved with 0.25% trace-metal clean buffered glutaraldehyde and centrifuged onto C/formvar-coated Au TEM grids. Grids were briefly rinsed with a drop of ultrapure water and dried in a Class-100 cabinet. SXRF analysis was performed using the 2-ID-E beamline at the Advanced Photon source (Argonne National Laboratory) following the protocols of Twining et al. (2011).

Data Processing Description

ICPMS: All data were normalized to an In-115 internal standard and quantified using an external standard curve. After accounting for sample dilutions due to acid digestion steps, quantities of each element per filter

(pmol/filter) were calculated for each analytical run. The contribution of the "bomb blank" (measured as the element concentration in an empty digestion vial treated like a sample) was then subtracted. We then subtracted the contribution of the "process blank" (measured as the elements contained in an acid-washed filter through which 0.2-micrometer filtered water was passed during the cruise). Separate process blanks were calculated for the labile (acetic acid/hydroxylamine), refractory (HCl/HNO₃/HF following acetic acid/hydroxylamine), and total (HCl/HNO₃/HF) digestions. The average process blanks for each digestion scheme and each element is given in the "process blanks" pdf document below.

Following blank corrections, element concentrations (per volume of water filtered) were calculated by dividing the pmol/filter measurements by the volume of water passed through each filter (measured volumetrically on the ship following each filtration).

Nearly all of the samples were well above the instrumental detection limits for all elements. The factor limiting our ability to detect particulate elements in the water is the signal associated with the process blank (i.e., the filter substrate itself). We therefore calculated the detection limits for the whole method as 3 times the standard deviation of the process blanks for the relevant digestion procedure (labile, refractory, or total). The elemental content of the process blank (pmol/filter) was converted into a concentration using the average volume filtered for either GO-Flo samples (6.5 L) or surface fish samples (2.8 L). The detection limits are reported.

Three data flags are used:

- 1: good
- 2: questionable
- 3: rejected
- 4: below detection limit of method

SXRF Between 9 and 20 cells were analyzed from the shallowest bottle and deep chlorophyll maximum at the subset of stations. The elemental content of each cell has been corrected for elements contained in the carbon substrate. Trace element concentrations are presented as mmol/mol P. Geometric mean concentrations (+/- standard error of the mean) are presented, along with the number of cells analyzed.

References:

Berger, C. J. M., S. M. Lippiatt, M. G. Lawrence, and K. W. Bruland. 2008. Application of a chemical leach technique for estimating labile particulate aluminum, iron, and manganese in the Columbia River plume and coastal waters off Oregon and Washington. *Journal of Geophysical Research-Oceans* 113.

Cutter, G. and others 2010. Sampling and sample-handling protocols for GEOTRACES cruises.

Twining, B. S., S. B. Baines, J. B. Bozard, S. Vogt, E. A. Walker, and D. M. Nelson. 2011. Metal quotas of plankton in the equatorial Pacific Ocean. *Deep-Sea Research II* 58: 325-341.

Related documents:

[GEOTRACES_NAZT_Twining_metadata_CRM_detection_limit.pdf](#)
[GEOTRACES_NAZT_Twining_metadata_CRM_precision.pdf](#)
[GEOTRACES_NAZT_Twining_metadata_CRM_process_blanks.pdf](#)
[GEOTRACES_NAZT_Twining_metadata_CRMs.pdf](#)

Additional GEOTRACES Processing:

After the data were submitted to the International Data Management Office, BODC, the office noticed that important identifying information was missing in many datasets. With the agreement of BODC and the US GEOTRACES lead PIs, BCO-DMO added standard US GEOTRACES information, such as the US GEOTRACES event number, to each submitted dataset lacking this information. To accomplish this, BCO-DMO compiled a 'master' dataset composed of the following parameters: station_GEOTRC, cast_GEOTRC (bottle and pump data only), event_GEOTRC, sample_GEOTRC, sample_bottle_GEOTRC (bottle data only), bottle_GEOTRC (bottle data only), depth_GEOTRC_CTD (bottle data only), depth_GEOTRC_CTD_rounded (bottle data only), BTL_ISO_DateTime_UTC (bottle data only), and GeoFish_id (GeoFish data only). This added information will facilitate subsequent analysis and inter comparison of the datasets.

Bottle parameters in the master file were taken from the GT-C_Bottle_GT10, GT-C_Bottle_GT11, ODF_Bottle_GT10, and ODF_Bottle_GT11 datasets. Non-bottle parameters, including those from GeoFish tows, Aerosol sampling, and McLane Pumps, were taken from the Event_Log_GT10 and Event_Log_GT11 datasets. McLane pump cast numbers missing in event logs were taken from the Particulate Th-234 dataset submitted by Ken Buesseler.

A standardized BCO-DMO method (called "join") was then used to merge the missing parameters to each US GEOTRACES dataset, most often by matching on sample_GEOTRC or on some unique combination of other parameters.

If the master parameters were included in the original data file and the values did not differ from the master file, the original data columns were retained and the names of the parameters were changed from the PI-submitted names to the standardized master names. If there were differences between the PI-supplied parameter values and those in the master file, both columns were retained. If the original data submission included all of the master parameters, no additional columns were added, but parameter names were modified to match the naming conventions of the master file.

See the dataset parameters documentation for a description of which parameters were supplied by the PI and which were added via the join method.

Version information:

August 2013 -- spreadsheet was resubmitted, replacing previous versions entirely. Reference materials (linked PDF files) were all updated. Awaiting review by contributor. Co and Zn were updated using corrected spreadsheet provided by Twining on Jan. 18 2013.

December 9, 2013: A completely new version of the data was submitted - a version that corresponds with the others in the project.

Feb. 18, 2014 -- Another revised data file was submitted, 2/18/2014. This one has the plankton data put back in. It was removed for the Intermediate Data Product assembly.

March 10, 2014: depth_PI was removed from displayed data.

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Data Files

File
<p>Particulate_Trace_Elements_joined_v5.csv(Comma Separated Values (.csv), 70.53 KB) <small>MD5:3bac69d242151fc858ce91eb8aed2f6b</small></p> <p>Primary data file for dataset ID 3841</p>

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Parameters

Parameter	Description	Units
cruise_id	Official cruise identifier e.g. KN199-04 = R/V Knorr cruise number 199-04.	dimensionless
sample_GEOTRC	Unique identifying number for US GEOTRACES samples; ranges from 5033 to 6078 for KN199-04 and from 6112 to 8148 for KN204-01. PI-supplied values were identical to those in the intermediate US GEOTRACES master file. Originally submitted as 'GeoTraces_ID', this parameter name has been changed to conform to BCO-DMO's GEOTRACES naming conventions.	dimensionless

station_GEOTRC	GEOTRACES station number; ranges from 1 through 12 for KN199-04 and 1 through 24 for KN204-01. Stations 7 and 9 were skipped on KN204-01. PI-supplied values were identical to those in the intermediate US GEOTRACES master file. Originally submitted as 'station', this parameter name has been changed to conform to BCO-DMO's GEOTRACES naming conventions.	integer
depth_comment	water mass description at sample depth	dimensionless
date	date, GMT	yyyymmdd
yday.UTC	day of year in GMT	integer
time	GMT time	hhmm
lat	Latitude (South is negative)	decimal degrees
lon	Longitude (West is negative)	decimal degrees
Cd_L	concentration of labile particulate cadmium	picomoles/liter
Cd_L_qc	concentration of labile particulate cadmium quality flag	dimensionless
Al_L	concentration of labile particulate aluminum	picomoles/liter
Al_L_qc	concentration of labile particulate aluminum quality flag	dimensionless
Mn_L	concentration of labile particulate manganese	picomoles/liter
Mn_L_qc	concentration of labile particulate manganese quality flag	dimensionless
Fe_L	concentration of labile particulate Iron	picomoles/liter
Fe_L_qc	concentration of labile particulate iron quality flag	dimensionless
Co_L	concentration of labile particulate cobalt	picomoles/liter
Co_L_qc	concentration of labile particulate cobalt quality flag	dimensionless

P_L	concentration of labile particulate phosphorus	picomoles/liter
P_L_qc	concentration of labile particulate phosphorus quality flag	dimensionless
Ti_L	concentration of labile particulate titanium	picomoles/liter
Ti_L_qc	concentration of labile particulate titanium quality flag	dimensionless
Cd_R	concentration of refractory particulate cadmium	picomoles/liter
Cd_R_qc	concentration of refractory particulate cadmium quality flag	dimensionless
Al_R	concentration of refractory particulate aluminum	picomoles/liter
Al_R_qc	concentration of refractory particulate aluminum quality flag	dimensionless
Mn_R	concentration of refractory particulate manganese	picomoles/liter
Mn_R_qc	concentration of refractory particulate manganese quality flag	dimensionless
Fe_R	concentration of refractory particulate Iron	picomoles/liter
Fe_R_qc	concentration of refractory particulate iron quality flag	dimensionless
Co_R	concentration of refractory particulate cobalt	picomoles/liter
Co_R_qc	concentration of refractory particulate cobalt quality flag	dimensionless
P_R	concentration of refractory particulate phosphorus	picomoles/liter
P_R_qc	concentration of refractory particulate phosphorus quality flag	dimensionless
Ti_R	concentration of refractory particulate titanium	picomoles/liter
Ti_R_qc	concentration of refractory particulate titanium quality flag	dimensionless
Cd_tot	concentration of total particulate cadmium	picomoles/liter

Cd_tot_qc	concentration of total particulate cadmium quality flag	dimensionless
Al_tot	concentration of total particulate aluminum	picomoles/liter
Al_tot_qc	concentration of total particulate aluminum quality flag	dimensionless
Mn_tot	concentration of total particulate manganese	picomoles/liter
Mn_tot_qc	concentration of total particulate manganese quality flag	dimensionless
Fe_tot	concentration of total particulate Iron	picomoles/liter
Fe_tot_qc	concentration of total particulate iron quality flag	dimensionless
Co_tot	concentration of total particulate cobalt	picomoles/liter
Co_tot_qc	concentration of total particulate cobalt quality flag	dimensionless
P_tot	concentration of total particulate phosphorus	picomoles/liter
P_tot_qc	concentration of total particulate phosphorus quality flag	dimensionless
Ti_tot	concentration of total particulate titanium	picomoles/liter
Ti_tot_qc	concentration of total particulate titanium quality flag	dimensionless
Mn_plankton	concentration of manganese in plankton cells	millimoles Mn/mole phosphorous
Mn_plankton_err	concentration of manganese in plankton cells standard error	millimoles Mn / mole phosphorous
Mn_plankton_count	cell count for concentration of manganese in plankton cells	dimensionless
Mn_plankton_qc	concentration of manganese in plankton cells quality flag	dimensionless
Fe_plankton	concentration of iron in plankton cells	millimoles Fe / mole phosphorous
Fe_plankton_err	concentration of iron in plankton cells standard error	millimoles Fe / mole phosphorous

Fe_plankton_count	cell count for concentration of iron in plankton cells	dimensionless
Fe_plankton_qc	concentration of iron in plankton cells quality flag	dimensionless
Co_plankton	concentration of cobalt in plankton cells	millimoles Co / mole phosphorous
Co_plankton_err	concentration of cobalt in plankton cells standard error	millimoles Co / mole phosphorous
Co_plankton_count	cell count for concentration of cobalt in plankton cells	dimensionless
Co_plankton_qc	concentration of cobalt in plankton cells quality flag	dimensionless
Ni_plankton	concentration of nickel in plankton cells	millimoles Ni / mole phosphorous
Ni_plankton_err	concentration of nickel in plankton cells standard error	millimoles Ni / mole phosphorous
Ni_plankton_count	cell count for concentration of nickel in plankton cells	dimensionless
Ni_plankton_qc	concentration of nickel in plankton cells quality flag	dimensionless
Zn_plankton	concentration of zinc in plankton cells	millimoles Zn / mole phosphorous
Zn_plankton_err	concentration of zinc in plankton cells standard error	millimoles Zn / mole phosphorous
Zn_plankton_count	cell count for concentration of zinc in plankton cells	dimensionless
Zn_plankton_qc	concentration of zinc in plankton cells quality flag	dimensionless
event_GEOTRC	Unique identifying number for US GEOTRACES sampling events; ranges from 2001 to 2225 for KN199-04 events and from 3001 to 3282 for KN204-01 events. Values were added from the intermediate US GEOTRACES master file (see Processing Description).	dimensionless
cast_GEOTRC	Cast identifier, numbered consecutively within a station. Values were added from the intermediate US GEOTRACES master file (see Processing Description).	dimensionless

sample_bottle_GEOTRC	Unique identification numbers given to samples taken from bottles; ranges from 1 to 24; often used synonymously with bottle number. Values were added from the intermediate US GEOTRACES master file (see Processing Description).	dimensionless
bottle_GEOTRC	Alphanumeric characters identifying bottle type (e.g., NIS representing Niskin and GF representing GOFLO) and position on a CTD rosette. Values were added from the intermediate US GEOTRACES master file (see Processing Description).	dimensionless
depth_GEOTRC_CTD	Observation/sample depth in meters, calculated from CTD pressure. Values were added from the intermediate US GEOTRACES master file (see Processing Description).	meters
BTL_ISO_DateTime_UTC	Date and time (UTC) variable recorded at the bottle sampling time in ISO compliant format. Values were added from the intermediate US GEOTRACES master file (see Processing Description). This standard is based on ISO 8601:2004(E) and takes on the following form: 2009-08-30T14:05:00[.xx]Z (UTC time)	YYYY-mm-ddTHH:MM:SS.ssZ
STA_ISO_DateTime_UTC	Station date and time (UTC) variable in ISO compliant format. Values were reformatted using date (YYYYmmdd and time(hhmm)). This standard is based on ISO 8601:2004(E) and takes on the following form: 2009-08-30T14:05:00[.xx]Z (UTC time) YYYY-mm-ddTHH:MM:SS.ssZ	YYYY-mm-ddTHH:MM:SS.ssZ

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Instruments

Dataset-specific Instrument Name	Mass Spectrometer
Generic Instrument Name	Mass Spectrometer
Generic Instrument Description	General term for instruments used to measure the mass-to-charge ratio of ions; generally used to find the composition of a sample by generating a mass spectrum representing the masses of sample components.

Dataset-specific Instrument Name	towed undulating vehicle
Generic Instrument Name	towed undulating vehicle
Generic Instrument Description	A towed undulating vehicle is a generic class of instruments. See the data set specific information for a detailed description. These are often prototype instrument packages designed to make very specific measurements.

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Deployments

KN199-04

Website	https://www.bco-dmo.org/deployment/58066
Platform	R/V Knorr
Report	http://bcodata.whoi.edu/US_GEOTRACES/AtlanticSection/Cruise_Report_for_Knorr_199_Final_v3.pdf
Start Date	2010-10-15
End Date	2010-11-04
Description	<p>This cruise constitutes the first survey section as part of the U.S. participation in an international program named GEOTRACES. Funding: NSF OCE award 0926423 Science Objectives: To obtain state of the art trace metal and isotope measurements on a suite of samples taken on a mid-latitude zonal transect of the North Atlantic. In particular, sampling targeted the oxygen minimum zone extending off the west African coast near Mauritania, the TAG hydrothermal field, and the western boundary current system along Line W. For additional information, please refer to the GEOTRACES program Web site (https://www.geotraces.org/) for overall program objectives and a summary of properties measured. Science Activities include seawater sampling via GoFLO and Niskin carousels, in situ pumping (and filtration), CTDO2 and transmissometer sensors, underway pumped sampling of surface waters, and collection of aerosols and rain. Hydrography, CTD and nutrient measurements were supported by the Ocean Data Facility (J. Swift) at Scripps Institution of Oceanography and funded through NSF Facilities. They provided an additional CTD rosette system along with nephelometer and LADCP. A trace metal clean Go-Flo Rosette and winch were provided by the group at Old Dominion University (G. Cutter) along with a towed underway pumping system. Additional cruise information is available from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/KN199-04 Other Relevant Links: List of cruise participants: [PDF] Cruise track: JPEG image (from Woods Hole Oceanographic Institution, vessel operator) ADCP data are available from the Currents ADCP group at the University of Hawaii: KN199-04 ADCP</p>

KN204-01

Website	https://www.bco-dmo.org/deployment/58786
Platform	R/V Knorr
Report	http://bcodata.whoi.edu/US_GEOTRACES/AtlanticSection/STS_Prelim_GT11_Doc.pdf
Start Date	2011-11-06
End Date	2011-12-11
Description	<p>The US GEOTRACES North Atlantic cruise aboard the R/V Knorr completed the section between Lisbon and Woods Hole that began in October 2010 but was rescheduled for November-December 2011. The R/V Knorr made a brief stop in Bermuda to exchange samples and personnel before continuing across the basin. Scientists disembarked in Praia, Cape Verde, on 11 December. The cruise was identified as KN204-01A (first part before Bermuda) and KN204-01B (after the Bermuda stop). However, the official deployment name for this cruise is KN204-01 and includes both part A and B. Science activities included: ODF 30 liter rosette CTD casts, ODU Trace metal rosette CTD casts, McLane particulate pump casts, underway sampling with towed fish and sampling from the shipboard "uncontaminated" flow-through system. Full depth stations are shown in the accompanying figure (see below). Additional stations to sample for selected trace metals to a depth of 1000 m are not shown. Standard stations are shown in red (as are the ports) and "super" stations, with extra casts to provide large-volume samples for selected parameters, are shown in green. Station spacing is concentrated along the western margin to evaluate the transport of trace elements and isotopes by western boundary currents. Stations across the gyre will allow scientists to examine trace element supply by Saharan dust, while also contrasting trace element and isotope distributions in the oligotrophic gyre with conditions near biologically productive ocean margins, both in the west, to be sampled now, and within the eastern boundary upwelling system off Mauritania, sampled last year. Funding: The cruise was funded by NSF OCE awards 0926204, 0926433 and 0926659. Additional cruise information is available from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/KN204-01 Other Relevant Links: ADCP data are available from the Currents ADCP group at the University of Hawaii at the links below: KN204-01A (part 1 of 2011 cruise; Woods Hole, MA to Bermuda) KN204-01B (part 2 of 2011 cruise; Bermuda to Cape Verde)</p>

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Project Information

U.S. GEOTRACES North Atlantic Transect (GA03) (U.S. GEOTRACES NAT)

Website: <https://www.geotraces.org/>

Coverage: Subtropical western and eastern North Atlantic Ocean (GA03)

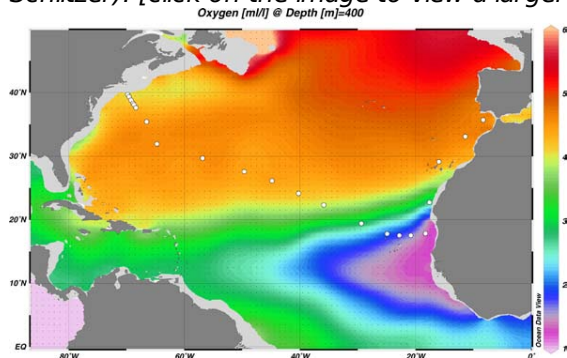
Much of this text appeared in an article published in OCB News, October 2008, by the OCB Project Office.

The first U.S. GEOTRACES Atlantic Section will be specifically centered around a sampling cruise to be carried out in the North Atlantic in 2010. Ed Boyle (MIT) and Bill Jenkins (WHOI) organized a three-day planning workshop that was held September 22-24, 2008 at the Woods Hole Oceanographic Institution. The main goal of the workshop, sponsored by the National Science Foundation and the U.S. GEOTRACES Scientific Steering Committee, was to design the implementation plan for the first U.S. GEOTRACES Atlantic Section. The primary cruise design motivation was to improve knowledge of the sources, sinks and internal cycling of Trace Elements and their Isotopes (TEIs) by studying their distributions along a section in the North Atlantic (Figure 1). The North Atlantic has the full suite of processes that affect TEIs, including strong meridional advection, boundary scavenging and source effects, aeolian deposition, and the salty Mediterranean Outflow. The North Atlantic is particularly important as it lies at the "origin" of the global Meridional Overturning Circulation.

It is well understood that many trace metals play important roles in biogeochemical processes and the carbon cycle, yet very little is known about their large-scale distributions and the regional scale processes that affect them. Recent advances in sampling and analytical techniques, along with advances in our understanding of their

roles in enzymatic and catalytic processes in the open ocean provide a natural opportunity to make substantial advances in our understanding of these important elements. Moreover, we are motivated by the prospect of global change and the need to understand the present and future workings of the ocean's biogeochemistry. The GEOTRACES strategy is to measure a broad suite of TEIs to constrain the critical biogeochemical processes that influence their distributions. In addition to these "exotic" substances, more traditional properties, including macronutrients (at micromolar and nanomolar levels), CTD, bio-optical parameters, and carbon system characteristics will be measured. The cruise starts at Line W, a repeat hydrographic section southeast of Cape Cod, extends to Bermuda and subsequently through the North Atlantic oligotrophic subtropical gyre, then transects into the African coast in the northern limb of the coastal upwelling region. From there, the cruise goes northward into the Mediterranean outflow. The station locations shown on the map are for the "fulldepth TEI" stations, and constitute approximately half of the stations to be ultimately occupied.

Figure 1. The proposed 2010 Atlantic GEOTRACES cruise track plotted on dissolved oxygen at 400 m depth. Data from the World Ocean Atlas (Levitus et al., 2005) were plotted using Ocean Data View (courtesy Reiner Schlitzer). [click on the image to view a larger version]

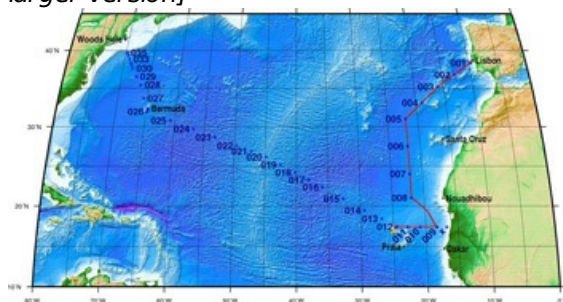


Hydrography, CTD and nutrient measurements will be supported by the Ocean Data Facility (J. Swift) at Scripps Institution of Oceanography and funded through NSF Facilities. They will be providing an additional CTD rosette system along with nephelometer and LADCP. A trace metal clean Go-Flo Rosette and winch system will be provided by the group at Old Dominion University (G. Cutter) along with a towed underway pumping system.

The North Atlantic Transect cruise began in 2010 with KN199 leg 4 (station sampling) and leg 5 (underway sampling only) (Figure 2).

[KN199-04 Cruise Report \(PDF\)](#)

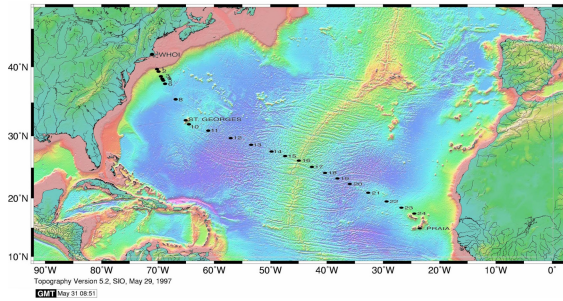
Figure 2. The red line shows the cruise track for the first leg of the US Geotraces North Atlantic Transect on the R/V Knorr in October 2010. The rest of the stations (beginning with 13) will be completed in October-December 2011 on the R/V Knorr (courtesy of Bill Jenkins, Chief Scientist, GNAT first leg). [click on the image to view a larger version]



The section completion effort resumed again in November 2011 with KN204-01A,B (Figure 3).

[KN204-01A,B Cruise Report \(PDF\)](#)

Figure 3. Station locations occupied on the US Geotraces North Atlantic Transect on the R/V Knorr in November 2011. [click on the image to view a larger version]



Data from the North Atlantic Transect cruises are available under the Datasets heading below, and consensus values for the SAFe and North Atlantic GEOTRACES Reference Seawater Samples are available from the GEOTRACES Program Office: [Standards and Reference Materials](#)

ADCP data are available from the Currents ADCP group at the University of Hawaii at the links below:

- [KN199-04](#) (leg 1 of 2010 cruise; Lisbon to Cape Verde)
- [KN199-05](#) (leg 2 of 2010 cruise; Cape Verde to Charleston, NC)
- [KN204-01A](#) (part 1 of 2011 cruise; Woods Hole, MA to Bermuda)
- [KN204-01B](#) (part 2 of 2011 cruise; Bermuda to Cape Verde)

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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-0928289

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