

# Dissolved lead (Pb), less than 0.2 $\mu\text{m}$ from R/V Knorr cruises KN199-04 and KN204-01 in the Subtropical northern Atlantic Ocean from 2010-2011 (U.S. GEOTRACES NAT project)

Website: <https://www.bco-dmo.org/dataset/3850>

Version: 07 Jan 2013

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## 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

Dissolved lead (Pb), the Pb passing through a 0.2 $\mu\text{m}$  Acropak capsule filter, is reported in picomoles Pb per kg of seawater. (The sample size was quantified volumetrically at room temperature, then converted to weight units assuming a density of 1.027 g/cc.) Samples were collected on the U.S. GEOTRACES North Atlantic Zonal Transect, Legs 1 and 2, in 2010 and 2011.

Please note that some US GEOTRACES data may not be final, pending intercalibration results and further analysis. If you are interested in following changes to US GEOTRACES NAT data, there is an RSS feed available via the BCO-DMO [US GEOTRACES project page](#) (scroll down and expand the "Datasets" section).

## Methods & Sampling

Sample storage bottle lids and threads were soaked overnight in 2N reagent grade HCl, then filled with 1N reagent grade HCl to be heated in an oven at 60 degrees C overnight, rotated, heated for a second day, and rinsed 5X with pure distilled water. The bottles were then filled with trace metal clean dilute HCl (~0.01N HCl) and again heated in the oven for one day on either end. Clean sample bottles were emptied, and double-bagged prior to rinsing and filling with sample.

Trace metal-clean seawater samples were collected using the U.S. GEOTRACES sampling system consisting of 24 Teflon-coated GO-FLO bottles that had been pre-rinsed with a 24+ hour treatment of filtered surface seawater at the beginning of the cruise (see Cutter & Bruland, 2012 for more information on the sampling system). At each station, the bottles were deployed open and tripped on ascent at 3 m/min. On deck, the bottles were kept in a trace metal clean sampling van over-pressurized with HEPA-filtered air, except immediately prior to and following deployments, in which cases they were covered on both ends with shower caps to avoid deck contamination.

During sampling in the clean van, the GO-FLO bottles were pressurized to ~0.4 atm with HEPA-filtered air, and their spigots were fitted with an acid-cleaned piece of Bev-a-Line tubing that fed into an Acropak-200 Supor capsule filter (0.2  $\mu\text{m}$  pore size made of polyethersulfone). Before use, this filter had been filled with filtered surface seawater that had been acidified to pH 2 with trace metal clean HCl and left overnight to rinse. Before collecting any subsamples, at least 500 mL of seawater was passed through the filter (while eliminating air bubbles in the capsule reservoir). Subsamples were taken into acid-cleaned (see above) Nalgene HDPE bottles after a double rinse with the sample. Acropak filters were used for at most 3 casts before a new filter was used, and they were stored empty in the refrigerator while not in use. GEOFish surface samples were taken using an all-plastic "towed fish" pumping system as described in Bruland et al. 2005 at approximately 2 m depth and were subsampled identically.

All samples were acidified at sea to pH 2 with trace metal clean 6N HCl. Samples were analyzed at least 1 month after acidification over 27 analytical sessions by the isotope-dilution ICP-MS method described in Lee et al. 2011, which includes pre-concentration on nitrilotriacetate (NTA) resin and analysis on a Fisons PQ2+ using a 400  $\mu\text{L}/\text{min}$  nebulizer. Briefly, samples were poured into 1.5 mL polyethylene vials (Eppendorf AG) in triplicate. Each sample was pipetted to 1.3 mL with the remaining solution. Pipettes were calibrated

daily to the desired volume. 25 µL of a Pb-204 spike were added to each sample, and the pH was raised to 5.3 using a trace metal clean ammonium acetate buffer, prepared at a pH of between 7.9 and 7.98. ~2400 beads of NTA Superflow resin (Qiagen Inc., Valencia, CA) were added to the mixture, and the vials were set to shake on a shaker for 4 days to allow the sample to equilibrate with the resin. After 4 days, the beads were centrifuged and washed 3 times with pure distilled water, using a trace metal clean syphon tip to remove the water wash from the sample vial following centrifugation. After the last wash, 250 µL of a 0.1N solution of trace metal clean HNO<sub>3</sub> was added to the resin to elute the metals, and the samples were allowed to sit for 2 days prior to analysis by ICP-MS.

NTA Superflow resin was cleaned by batch rinsing with 0.1N trace metal clean HCl for a few hours, followed by multiple washes until the pH of the solution was above 4. Resin was stored at 4 degrees C in the dark until use, though it was allowed to equilibrate to room temperature prior to the addition to the sample.

Eppendorf polyethylene vials were cleaned by heated submersion for 2 days at 60 degrees C in 1N reagent grade HCl, followed by a bulk rinse and 4X individual rinse of each vial with pure distilled water. Each vial was then filled with trace metal clean dilute HCl (~0.01N HCl) and heated in the oven at 60 degrees C for one day on either end. Vials were kept filled until just before usage.

On each day of sample analyses, procedure blanks were determined using 12 replicates of 300 µL of an in-house standard reference material seawater (low Pb surface water), where the amount of Pb in the 300 µL was verified as negligible. The procedure blank over the relevant sessions ranged from 1.4-6.9 pmol/kg, averaging 2.9 pmol/kg. Within a day, procedure blanks were very reproducible with an average standard deviation of 0.4 pmol/kg, resulting in a detection limit (3x this standard deviation) of 1.2 pmol/kg. Replicate analyses of two large-volume seawater samples (one with ~35 pmol/kg and the other with ~63 pmol/kg) indicates that the precision of the analysis is 3% or 0.5 pmol/kg, whichever is larger.

Triplicate analyses of international reference standards linked into the investigators' lab standard reference frame gave:

SAFe S1: 46.0 +/- 2.2 pmol/kg

SAFe D1: 22.9 +/- 1.2 pmol/kg

US-GT-IC1-GS: 26.8 +/- 2.2 pmol/kg

US-GT-IC1-GD: 41.8 +/- 1.7 pmol/kg

For the most part, the reported numbers are simply as calculated from the isotope dilution equation on the day of the analysis. For some stations, however, small offsets between samples run on different days or quality control samples indicated offsets, so further re-runs were used to determine which day was correct. For USGT11-05 (KN204-01 station 5) and USGT11-17 (KN204-01 station 17) the quality control samples indicated that the daily numbers were 5% high compared to the long-term average, and the investigators applied a -5% correction to the Pb concentrations from that day. For USGT11-11, USGT11-13, and USGT11-15 the quality control samples indicated that the investigators' daily numbers were 4% high compared to their long-term average, and they applied a -4% correction to their Pb concentrations from that day. For USGT10-12 (KN199-04 station 12), the investigators applied a constant offset correction of -2.5 pmol/kg to the data from the day on which most samples were run. For USGT11-10, the quality control samples indicated that the investigators' daily numbers were 3% low compared to their long-term average, and they applied a +3% correction to their Pb concentrations from that day (this also improved the agreement with the Bruland and Middag numbers). With these corrections, the overall internal comparability of the Pb collection should be better than 1-2%.

In addition, Drs. Ken Bruland and Rob Middag analyzed separate samples from US-GT-NAT-2011 stations 10, 12, and 20 using a different analytical scheme and the agreement between the two labs was within the 3% precision quoted above before any corrections were applied, and within 1-2% after the corrections noted above were applied. The investigators have also used this method to re-analyze samples collected by their lab and analyzed many years ago by a different analytical method (ID-Mg(OH)<sub>2</sub> coprecipitation) and the analyses agreed within 5%. The investigators expect this level of precision will apply between the present dataset and their previous data analyzed by ID-Mg(OH)<sub>2</sub> coprecipitation.

Most of the US GT-10 cruise samples were analyzed by Yolanda Echegoyen-Sanz, and all of the US GT-11 samples were analyzed by Abigail Noble, with no significant difference between them for the low concentration reference sample (both analysts averaged 34.8 pmol/kg).

#### References:

Lee, J.-M., Boyle, E.A., Echegoyen-Sanz, Y., Fitzsimmons, J.N., Zhang, R., and Kayser, R.A. 2011. Analysis of trace metals (Cu, Cd, Pb, and Fe) in seawater using single batch nitrilotriacetate resin extraction and isotope dilution inductively coupled plasma mass spectrometry. *Analytica Chimica Acta* 686: 93-101. doi: [10.1016/j.aca.2010.11.052](https://doi.org/10.1016/j.aca.2010.11.052)

#### Data Processing Description

Samples were analyzed in triplicate, and average values shown in this database were only accepted if reproduced over at least two replicates; otherwise, the data was re-analyzed until a reproducible value was reached.

The standard Ocean Data View flags were used. A descriptor of all flags is available on line at [https://www.bodc.ac.uk/data/codes\\_and\\_formats/odv\\_format/](https://www.bodc.ac.uk/data/codes_and_formats/odv_format/). Flags used in this dataset are as follows:

1 = Good Value: Good quality data value that is not part of any identified malfunction and has been verified as consistent with real phenomena during the quality control process.

2 = Probably Good Value: Data value that is probably consistent with real phenomena but this is unconfirmed or data value forming part of a malfunction that is considered too small to affect the overall quality of the data object of which it is a part. (Used when only one replicate confirmed the reported value.)

3 = Probably Bad Value: Data value recognized as unusual during quality control that forms part of a feature that is probably inconsistent with real phenomena.

4 = Bad Value: An obviously erroneous data value.

6 = Value Below Detection Limit: The level of the measured phenomenon was too small to be quantified by the technique employed to measure it. The accompanying value is the detection limit for the technique or zero if that value is unknown.

9 = Missing Value: The data value is missing. Any accompanying value will be a magic number representing absent data. (All samples collected were analyzed. Any missing data was not collected.)

In this data set, the investigators did not encounter any samples that did not yield acceptably reproducible results upon repeated analysis, so they believe that the data truly represents the concentration of Pb in the sample collection bottle. However, there were a few points that were high based on adjacent samples and for which an obvious hydrographic argument could not be made for the anomaly. These samples may be contaminated, and they are given the quality control flag of 3 (probably bad value).

#### **BCO-DMO made the following changes:**

- Parameter names were modified to conform with BCO-DMO naming conventions.
- Blank cells were replaced with 'nd' to indicate 'no data'.
- cruise\_part was separated from the official cruise ID for cruise KN204-01.
- added ISO\_DateTime\_UTC from the original date and time fields.
- added coordinates for sample #5622 (KN199-04 station 9) from G. Cutter's Nanomolar Surface Nutrients dataset.

#### **Dataset updated 21 June 2013. Updates include:**

- KN204-01b Station 10 Pb concentration data has been increased by 3% based on 3 quality control samples offsets.
- Several samples were analyzed that were accidentally omitted from the initial data submission. These have been added to the dataset.
- GT11-17, GT#7525 was reported as having a concentration of 0. The correct value is 24.9, n=2, stdev =0.5.
- Several event numbers have been corrected.

#### **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.

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## **Data Files**

File
<b>Pb_GT10-11_joined.csv</b> (Comma Separated Values (.csv), 101.14 KB) MD5:1770e862fc181c9d4c5f4c918c681723
Primary data file for dataset ID 3850

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## **Parameters**

Parameter	Description	Units
cruise_id	Official cruise identifier e.g. KN199-04 = R/V Knorr cruise number 199-04.	text
cruise_name	GEOTRACES cruise identifier.	text
expo_code	Expedition code.	text
cruise_part	Part of cruise. For KN204-01: A = 11/6/2011 to 11/18/2011 (Woods Hole to Bermuda) B = 11/19/2011 to 12/11/2011 (Bermuda to Praia, Cabo Verde)	text
station	Station number; provided in original data submission.	integer
cast_GEOTRC	Cast identifier numbered consecutively within a station. PI-supplied values were identical to those in the intermediate US GEOTRACES master file. Originally submitted as 'CASTNO', this parameter name has been changed to conform to BCO-DMO's GEOTRACES naming conventions.	integer
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. PI-supplied values were identical to those in the intermediate US GEOTRACES master file. Originally submitted as 'GEOTRC_EVENTNO', this parameter name has been changed to conform to BCO-DMO's GEOTRACES naming conventions.	integer
date	Date (UTC).	YYYYmdd
time	Time (UTC). 24-hour clock.	HHMM
lat	Latitude. South is negative.	decimal degrees
lon	Longitude. West is negative.	decimal degrees
press	Pressure (from CTD). Originally named 'CTDPRS'.	decibars
depth	Depth; provided in original data submission.	meters
Pb_diss	Dissolved lead (Pb). The Pb passing through a 0.2 um Acropak capsule filter measured in picomoles Pb per kilogram of seawater.	pmol/kg
Pb_diss_flag	Quality flag for Pb_diss. See 'Processing Description' for code definitions.	unitless
no_reps	Number of replicates.	integer
Pb_diss_sd	Standard deviation of replicates of Pb_diss.	pmol/kg
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 'GEOTRC_SAMPNO', this parameter name has been changed to conform to BCO-DMO's GEOTRACES naming conventions.	integer
sample_bottle_GEOTRC	Unique identification numbers given to samples taken from bottles; ranges from 1 to 24; often used synonymously with bottle number. PI-supplied values were identical to those in the intermediate US GEOTRACES master file. Originally submitted as 'SAMPNO', this parameter name has been changed to conform to BCO-DMO's GEOTRACES naming conventions.	integer
bottle_GEOTRC	Alphanumeric characters identifying bottle type (e.g., NIS representing Niskin and GF representing GOFLO) and position on a CTD rosette. PI-supplied values were identical to those in the intermediate US GEOTRACES master file. Originally submitted as 'BTLNBR', this parameter name has been changed to conform to BCO-DMO's GEOTRACES naming conventions.	unitless
bot_flag	Bottle quality flag (originally named 'BTLNBR_FLAG_W'), following the WOCE protocol. See <a href="http://woce.nodc.noaa.gov/woce_v3/wocedata_1/whp/exchange/exchange_format_desc.htm">http://woce.nodc.noaa.gov/woce_v3/wocedata_1/whp/exchange/exchange_format_desc.htm</a> .	unitless
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. Some GeoFish stations are denoted as X_to_Y indicating the tow occurred between stations X and Y. 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[.xx][+/-TZ]
ISO_DateTime.UTC	Cast date/time (UTC) formatted to ISO8601 standard. T indicates start of time string; Z indicates UTC. Calculated from original date and time fields.	YYYY-mm-ddTHH:MM:SS.ssZ

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## Instruments

<b>Dataset-specific Instrument Name</b>	GeoFish
<b>Generic Instrument Name</b>	GeoFish Towed near-Surface Sampler
<b>Dataset-specific Description</b>	GEOFish surface samples were taken using an all-plastic "towed fish" pumping system as described in Bruland et al. 2005.
<b>Generic Instrument Description</b>	The GeoFish towed sampler is a custom designed near surface (

<b>Dataset-specific Instrument Name</b>	GO-FLO Bottle
<b>Generic Instrument Name</b>	GO-FLO Bottle
<b>Dataset-specific Description</b>	Trace metal-clean seawater samples were collected using the U.S. GEOTRACES sampling system consisting of 24 Teflon-coated GO-FLO bottles (see Cutter & Bruland, 2012).
<b>Generic Instrument Description</b>	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.

<b>Dataset-specific Instrument Name</b>	Isotope-ratio Mass Spectrometer
<b>Generic Instrument Name</b>	Isotope-ratio Mass Spectrometer
<b>Dataset-specific Description</b>	Samples analyzed by the isotope-dilution ICP-MS method described in Lee et al. 2011, which includes pre-concentration on nitrilotriacetate (NTA) resin and analysis on a Fisons PQ2+ using a 400 uL/min nebulizer.
<b>Generic Instrument Description</b>	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

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## Deployments

### KN199-04

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58066">https://www.bco-dmo.org/deployment/58066</a>
<b>Platform</b>	R/V Knorr
<b>Report</b>	<a href="http://bcodata.whoi.edu/US_GEOTRACES/AtlanticSection/Cruise_Report_for_Knorr_199_Final_v3.pdf">http://bcodata.whoi.edu/US_GEOTRACES/AtlanticSection/Cruise_Report_for_Knorr_199_Final_v3.pdf</a>
<b>Start Date</b>	2010-10-15
<b>End Date</b>	2010-11-04
<b>Description</b>	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 ( <a href="https://www.geotraces.org/">https://www.geotraces.org/</a> ) 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): <a href="https://www.rvdata.us/search/cruise/KN199-04">https://www.rvdata.us/search/cruise/KN199-04</a> 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

### KN204-01

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58786">https://www.bco-dmo.org/deployment/58786</a>
<b>Platform</b>	R/V Knorr
<b>Report</b>	<a href="http://bcodata.whoi.edu/US_GEOTRACES/AtlanticSection/STS_Prelim_GT11_Doc.pdf">http://bcodata.whoi.edu/US_GEOTRACES/AtlanticSection/STS_Prelim_GT11_Doc.pdf</a>
<b>Start Date</b>	2011-11-06
<b>End Date</b>	2011-12-11
<b>Description</b>	<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): <a href="https://www.rvdata.us/search/cruise/KN204-01">https://www.rvdata.us/search/cruise/KN204-01</a> 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)

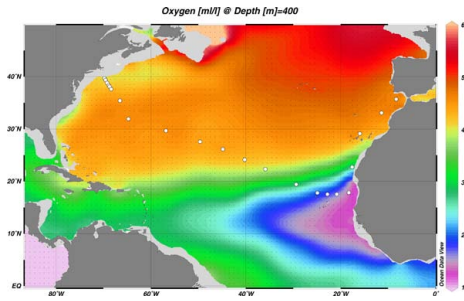
*Much of this text appeared in an article published in OCB News, October 2008, by the OCB Project Office.*

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]*



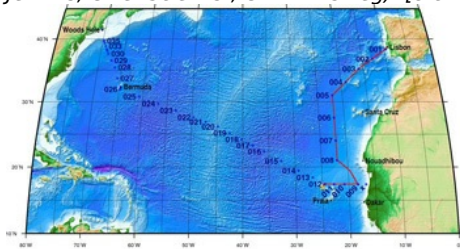


Hydrography, CTD and nutrient measurements will be supported by the Ocean Data Facility (J. Swift) at Scripps Institution of Oceanography and funded through NSF Facilities. They will be providing an additional CTD rosette system along with nephelometer and LADCP. A trace metal clean Go-Flo Rosette and winch 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 \(PDF\)](#)

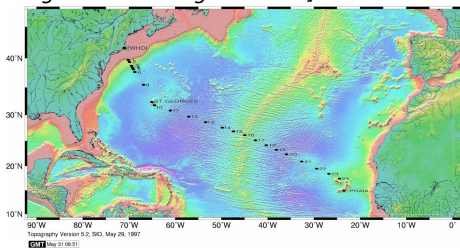
Figure 2. The red line shows the cruise track for the first leg of the US Geotraces North Atlantic Transect on the R/V Knorr in October 2010. The rest of the stations (beginning with 13) will be completed in October-December 2011 on the R/V Knorr (courtesy of Bill Jenkins, Chief Scientist, GNAT first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

<b>Funding Source</b>	<b>Award</b>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-0926197</a>

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