# Depth profiles of suspended dissolved and particulate 232Th, 230Th, and 231Pa from R/V Knorr KN199-04, KN204-01, subtropical North Atlantic Ocean from 2010-2011 (U.S. GEOTRACES NAT project)

**Website**: https://www.bco-dmo.org/dataset/3870
**Version**: 2
**Version Date**: 2014-08-08

**Project**
» U.S. GEOTRACES North Atlantic Transect (GA03) (U.S. GEOTRACES NAT)

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

| Contributors | Affiliation | Role |
|---|---|---|
| Anderson, Robert F. | Lamont-Doherty Earth Observatory (LDEO) | Principal Investigator |
| Fleisher, Martin Q. | Lamont-Doherty Earth Observatory (LDEO) | Co-Principal Investigator |
| Hayes, Christopher T. | Lamont-Doherty Earth Observatory (LDEO) | Contact |
| Copley, Nancy | Woods Hole Oceanographic Institution (WHOI BCO-DMO) | BCO-DMO Data Manager |

## Table of Contents



## Dataset Description

**DMO NOTE on GNAZT Suspended Particulate Th/Pa:**
- version 4 served on 29 Sept 2015; combined both dissolved and particulate Th & Pa datasets into one.
**See dataset "GT10-11 - Dissolved and Particulate Th and Pa"**
- version 3: none
- version 2: 8 Aug. 2014
- version 1: 31 Jan. 2013

**Notes:**

This data refers to the "suspended" size fraction of seawater particles (written with the suffix "_susp"). The particulate samples were collected by in-situ pumping over paired 0.8?m Pall Supor800 polyethersulfone filters behind a 51 ?m Sefar polyester mesh prefilter (See sampling Methodology below for details). Analysis of the paired Supor filters represents a particle size class approximating 0.45-51 µm (Bishop et al. 2012), while the top filter alone represents 0.8-51 µm and it is this size class referred to here as "suspended". We measured a select number of top and bottom filters separately for radionuclides and found that the bottom filters had radionuclide levels that were indistinguishable from clean filter process blanks. Therefore whether or not samples were analyzed as top and bottom paired, or the top filter alone, we refer to the particle size class represented as 0.8-51 µm.

Radionuclide concentrations are given as the mass of radionuclide contained in a given volume of pumped

seawater: femtograms (fg = 10-15 g) radionuclide per kilogram (kg) seawater for 230Th and 231Pa, and picograms (pg = 10-12 g) radionuclide per kg seawater for 232Th. Sample size was measured by volume (liters) of seawater pumped by mass flow controllers on the in-situ pumps, but we converted seawater volume to seawater mass using a fixed seawater density of 1.025 kg/L. The units are written simply as fg/kg and pg/kg. Note that the counterpart radionuclide data in the dissolved phase (<0.45 µm) from this CRUISE are also reported in fg and pg per kilogram of seawater. Concentrations below detection are listed as 'bdl'.

**Methods & Sampling**

**Sampling and Analytical Methodology:**
**1. Sampling:**
Size-fractionated particles were collected using McLane Research in-situ pumps (WTS-LV) that had been modified to accommodate two flowpaths (Lam and Morris Patent pending). The wire-out was used to target depths during deployment, and a self-recording Seabird 19plus CTD deployed at the end of the line and RBR data loggers attached to three of the eight pumps were used to correct for actual depths during pumping.

Filter holders used were 142 mm-diameter "mini-MULVFS" style filter holders with two stages for two size fractions and multiple baffle systems designed to ensure even particle distribution and prevent particle loss (Bishop et al. 2012). One of two filter holder/flowpaths was loaded with a 51µm Sefar polyester mesh prefilter followed by paired 0.8 µm Pall Supor800 polyethersulfone filters. Each cast also had "dipped blank" filters deployed. These were the full filters sets (prefilter followed by paired Supor filters) sandwiched within a 1 µm polyester mesh filter, loaded into perforated polypropylene containers, attached with plastic cable ties to a pump frame, and deployed. Dipped blank filters were exposed to seawater for the length of the deployment and processed and analyzed as regular samples, and thus functioned as full seawater process blanks. We analyzed half portions of the top and bottom filters from the "dipped" blank from 1 or more depths for 7 stations.

All filters and filter holders were acid leached prior to use according to methods recommended in the GEOTRACES sample and sample-handing Protocols (Geotraces 2010).

**2. Analysis:**
The Supor filters were subsampled in an on-shore laboratory at the Woods Hole Oceanographic Institution and shipped to the participating labs for Pa/Th analysis. Twenty-five to 50% of the paired Supor filters, representing 55-350 L of seawater, were used for Pa/Th analysis. Analyses were similar but differed slightly for the Lamont-Doherty Earth Observatory, WHOI and the University of Minnesota. Details of each groups methodologies can be found in reports by Anderson et al. (2012), Auro et al. (2012) and Shen et al. (2002, 2003, 2012), respectively. Below we give a typical procedure used at L-DEO for illustrative purposes.

**2.1 L-DEO procedures**

Filters were folded into 60 mL Teflon jars and weighed aliquots of the artificial isotope yield monitors 229Th (1 pg) and 233Pa (0.3-0.4 pg) and 7-8 mg dissolved Fe were added to each sample. Filters were first heated in ~5 mL 8 N $HNO_3$ for 1-2 hours at 150°C, then 4-5 mL $HClO_4$ was added and heat was increased to 200°C until dense white fumes appeared for ~10-20 min. The heat was then reduced to 180°C and the samples were covered with a Teflon watch cover. After 1-4 hrs, oxidation of the Supor material accelerated, sometimes producing a foam. A foamed sample would be allowed to cool, and re-heated after the beaker walls and watch cover were washed with small amounts of $HNO_3$ or Milli-Q water. When the Supor material was largely broken down, the watch covers were removed and HF was added in 2 aliquots of ~10-15 drops in between reheating until attaining dense $HClO_4$ fumes for at least 10 min.

After total dissolution of the sample, the sample-$HClO_4$ residue was taken up in dilute HCl, and transferred to 50 mL centrifuge tubes with water rinses. Ten to 20 drops of $NH_4OH$ were added to raise pH to 8-8.5 when iron (oxy)hydroxide precipitated. This precipitate was then centrifuged, decanted, washed with Milli-Q $H_2O$, centrifuged, and dissolved in 12 M HCl for a series of anion-exchange chromatography using 6 mL polypropylene columns each containing a 1 mL bed of Bio-rad resin (AG1-X8, 100-200 mesh size) and a 45 µm porous polyethylene frit (Anderson et al. 2012). The final column elutions were dried down at 180°C in the presence of 2 drops of $HClO_4$ and taken up in approximately 1 mL of 0.16 M $HNO_3$/0.026 M HF for mass spectrometric analysis. All acids and bases used were Fisher Chemical OPTIMA grade.

Concentrations of 232Th, 230Th and 231Pa were calculated by isotope dilution using nuclide ratios determined on a Thermo Scientific Element XR Inductively-couple plasma mass spectrometer (ICP-MS) in low resolution. All measurements were done using a peak jumping routine in ion counting mode. A solution of SRM129, a natural

U standard, was run to determine the mass bias correction (assuming that the mass fractionation for Th and Pa are the same as for U). Each sample measurement was bracketed by measurement of an aliquot of the run solution, used to correct for the instrument background count rates on the masses measured. To correct for potential tailing of 232Th into the minor Th and Pa isotopes, beam intensities were measured at the half masses above and below each mass for 230Th, 231Pa, and 233Pa. Tailing under each minor isotope was estimated as the log mean intensity of the half masses on either side of each minor isotope.

**2.2 Blank determinations**

In addition to laboratory procedural blanks (reagents/labware blanks) and periodic measurements of an intercalibrated working standard solution of 232Th, 230Th and 231Pa, SW STD 2010-1 referred to by Anderson et al. (2012), the participating labs also analyzed a number (n = 23) of "dipped blank" filters, mentioned above, to determine the total blank, associated with the sample collection and handling in addition to the laboratory procedure.

For better statistics, we pooled all procedural blank corrected "dipped" blanks (n = 23) to determine filter blank corrections. "Dipped" filter blanks for 232Th, 230Th, and 231Pa were from 156 ± 57 pg, 5.8 ± 2.0 fg, and 0.12 ± 0.04 fg, respectively. Total blanks were < 10% of the measured isotope amounts, except shallower than 200 m water depth, where blanks could be on the order of 50% of the measured 230Th and 231Pa.

We define the limit of detection as 3 times the standard deviation in the measured "dipped" blanks (170 pg 232Th, 6.0 fg 230Th, and 0.13 fg 231Pa). There were 5 samples for which 231Pa was considered below detection, and all other samples were above the cited limits.

Further details on analysis of seawater particulate radionuclides are given by Anderson et al. (2012).

**Data Processing Description**

**Data Processing:**
The reported errors for radionuclide concentrations represent the propagation of 2 standard errors, based on the standard deviation of the average isotope ratios collected by ICP-MS, estimated error in the 229Th or 233Pa spike concentration, and the total blank correction.

**Related files and references:**
Anderson, R.F., Fleisher, M.Q., Robinson, L.F., Edwards, R.L., Hoff, J., Moran, S.B., Rutgers van der Loeff, M.M., Thomas, A.L., Roy-Barman, M., François, R., 2012. GEOTRACES intercalibration of 230Th, 232Th, 231Pa, and prospects for 10Be. Limnol. Oceanogr. Methods 10, 179-213.

Auro, M.E., Robinson, L.F., Burke, A., Bradtmiller, L.I., Fleisher, M.Q., Anderson, R.F., 2012. Improvements to 232-thorium, 230-thorium, and 231-protactinium analysis in seawater arising from GEOTRACES intercalibration. Limnol. Oceanogr. Methods 10, 464-474.

Bishop, J. K. B., P. J. Lam, and T. J. Wood. 2012. Getting good particles: accurate sampling of particles by large volume in-situ filtration. Limnology and Oceanography Methods 10: 681-710.

Lam, P. J., and P. J. Morris. Patent pending. In situ marine sample collection system and methods, Goodwin Docket No. WHOI-005PR.

Geotraces. 2010. Sample and sample-handing protocols for GEOTRACES Cruises. In Standards and Intercalibration Committee [ed.]. http://www.geotraces.org/libraries/documents/Intercalibration/Cookbook.pdf

**Additional GEOTRACES Processing Performed by BCO-DMO:** 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 name 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.

[ table of contents | back to top ]

## Data Files

| File |
|---|
| **ThPa_all_GT10-11_v4.csv** (Comma Separated Values (.csv), 220.93 KB)<br>MD5:d357a60518b2d4bb6b9767e0e332c29a<br>Primary data file for dataset ID 3870 |

[ table of contents | back to top ]

## Parameters

| Parameter | Description | Units |
|---|---|---|
| cruise_id | Official cruise identifier e.g. KN199-04 = R/V Knorr cruise number 199-04. | text |
| cruise_part | identifier for a segment of a leg of a cruise, where a leg may have been broken into parts. | text |
| 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 |
| lat_sta | nominal station latitude; north is positive | decimal degrees |
| lon_sta | nominal station longitude; east is positive | decimal degrees |
| 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 'cast'; 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 'event'; this parameter name has been changed to conform to BCO-DMO's GEOTRACES naming conventions. | dimensionless |
| depth_GEOTRC_CTD | Observation/sample depth in meters; calculated from CTD pressure. PI-supplied values were identical to those in the intermediate US GEOTRACES master file. Originally submitted as 'depth'; this parameter name has been changed to conform to BCO-DMO's GEOTRACES naming conventions. | meters |
| pump | McClane in-situ pump identifier | 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 'sample', this parameter name has been changed to conform to BCO-DMO's GEOTRACES naming conventions. | integer |
| Th232_susp | suspended 232Th conc. (0.45-51 um) | picograms 232Th per L seawater |
| Th232_susp_err | 2 standard error uncertainty in 232Th_susp | picograms 232Th per L seawater |
| Th232_susp_flag | data quality flag for 232Th_susp | 1 = good; 2 = questionable; 3 = bad |
| Th230_susp | suspended 230Th conc. (0.45-51 um) | femtograms 230Th per L seawater |
| Th230_susp_err | 2 standard error uncertainty in 230Th_susp | femtograms 230Th per L seawater |
| Th230_susp_flag | data quality flag for 230Th_susp | 1 = good; 2 = questionable; 3 = bad |
| Pa231_susp | suspended 231Pa conc. (0.45-51 um) | femtograms 231Pa per L seawater |
| Pa231_susp_err | 2 standard error uncertainty in 231Pa_susp | femtograms 231Pa per L seawater |
| Pa231_susp_flag | data quality flag for 231Pa_susp | 1 = good; 2 = questionable; 3 = bad |
| 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 |
| 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] |
| lab | location of analysis: WHOI = Woods Hole Oceanographic Institution; LDEO = Lamont Doherty Earth Observatory; UMinn = University of Minnesota | unitless |
| depth | sample depth reported by PI | meters |

[ table of contents | back to top ]

## Instruments

| | |
|---|---|
| **Dataset-specific Instrument Name** | Mass Spectrometer |
| **Generic Instrument Name** | Mass Spectrometer |
| **Dataset-specific Description** | Thermo Scientific Element XR Inductively-couple plasma mass spectrometer (ICP-MS) |
| **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** | McLane Pump |
| **Generic Instrument Name** | McLane Pump |
| **Dataset-specific Description** | McLane Research in-situ pumps (WTS-LV) that had been modified to accommodate two flowpaths (Lam and Morris Patent pending). The wire-out was used to target depths during deployment, and a self-recording Seabird 19plus CTD deployed at the end of the line and RBR data loggers attached to three of the eight pumps were used to correct for actual depths during pumping. Samples were collected with the pump over paired 0.8um Pall Supor800 polyethersulfone filters behind a 51 um Sefar polyester mesh prefilter (See sampling Methodology for details). 142 mm-diameter "mini-MULVFS" style filter holders with two stages for two size fractions and multiple baffle systems designed to ensure even particle distribution and prevent particle loss (Bishop et al. 2012). One of two filter holder/flowpaths was loaded with a 51µm Sefar polyester mesh prefilter followed by paired 0.8 µm Pall Supor800 polyethersulfone filters. |
| **Generic Instrument Description** | McLane pumps sample large volumes of seawater at depth. They are attached to a wire and lowered to different depths in the ocean. As the water is pumped through the filter, particles suspended in the ocean are collected on the filters. The pumps are then retrieved and the contents of the filters are analyzed in a lab. |

[ table of contents | back to top ]

## 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** | 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 |

**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** | 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) |

[ table of contents | back to top ]

## 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)

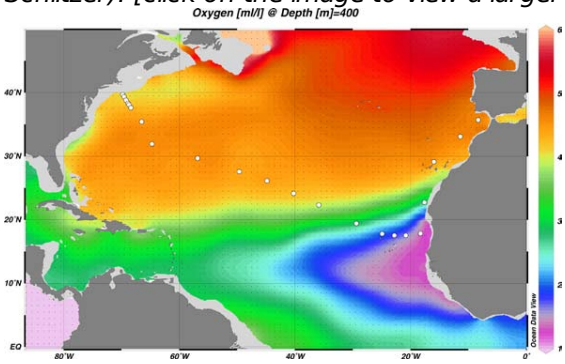
*Much of this text appeared in an article published in OCB News, October 2008, by the OCB Project Office.*

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]*

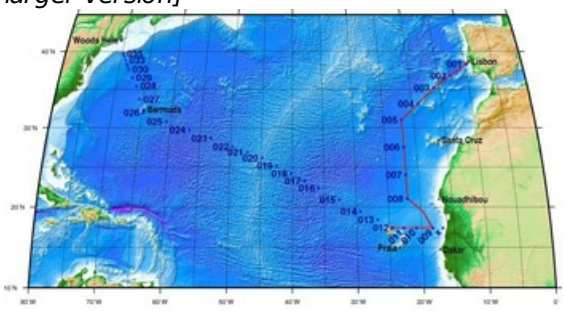



Hydrography, CTD and nutrient measurements will be supported by the Ocean Data Facility (J. Swift) at Scripps Institution of Oceanography and funded through NSF Facilities. They will be providing an additional CTD rosette system along with nephelometer and LADCP. A trace metal clean Go-Flo Rosette and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

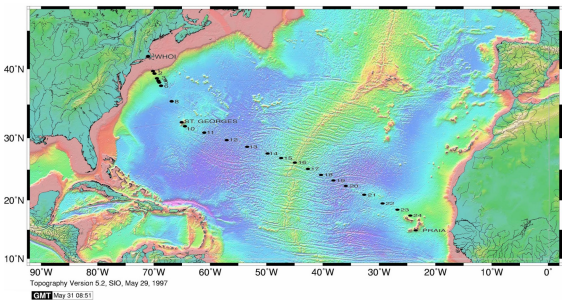
*Figure 2. The red line shows the cruise track for the first leg of the US Geotraces North Atlantic Transect on the R/V Knorr in October 2010. The rest of the stations (beginning with 13) will be completed in October-December 2011 on the R/V Knorr (courtesy of Bill Jenkins, Chief Scientist, GNAT first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

[ table of contents | back to top ]

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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.

[ table of contents | back to top ]

## Funding


| Funding Source | Award |
| --- | --- |
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[ table of contents | back to top ]