

Isotope ratios of Pb passing through a 0.2um Acropak capsule filter from the US GEOTRACES Arctic Expedition (GN01, HLY1502) from August to October 2015

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Project

- » [U.S. Arctic GEOTRACES Study](#) (U.S. GEOTRACES Arctic)
- » [Collaborative Research: GEOTRACES Arctic section: Spatial variability of lead concentrations and isotopic compositions in the western Arctic basins](#) (GEOTRACES Arctic Pb)

Program

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

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Abstract

Isotope ratios of Pb passing through a 0.2um Acropak capsule filter from the US GEOTRACES Arctic Expedition (GN01, HLY1502) from August to October 2015.

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Coverage

Spatial Extent: N:89.995 E:179.5926 S:60.165 W:-179.8082

Temporal Extent: 2015-08-12 - 2015-10-05

Acquisition Description

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 °C overnight, inverted, 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, rinsed with distilled water, and double-bagged prior to shipboard 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 and 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.

Samples were analyzed at least 1 month after acidification over 11 mass spectrometry sessions by a modified method based on that described by Reuer et al. (2003) as modified by Boyle et al. (2012) and further slightly modified as noted in the following.

The shallowest samples were collected using a pumping system on board a small boat deployed from the main ship. At each station a homogenized 25L carboy sample was 0.2 um supor capsule filtered on board the small boat, and subsampled into community provided bottles inside the main lab bubble. At station 10, due to issues with the pump, an unfiltered carboy sample was collected by submerging the carboy into the water from the small boat. On-board analysis determined this sample was grossly contaminated for Zn. At station 51, to reduce the time spent on the small boat during rough weather conditions, an unfiltered carboy sample was collected with the pump and filtered on board. MIT Pb samples were transferred into warm-acid leached Nalgene 2-liter polyethylene bottles with polypropylene caps, rinsed 3 times with the sample. Bottles were then capped and not further handled until returned to MIT a few months later, where they were acidified to pH 2.0 with high-purity HCl and allowed to sit for a few months before analysis.

Nobias Chelate PA1 preconcentration followed by anion exchange purification:

This method starts with a new double batch ion-exchange chelation preconcentration followed by the Reuer et al. (2003) anion exchange purification followed by isotope ratio analysis on a GV/Micromass IsoProbe multicollector ICPMS using a 50 uL/min nebulizer aspirated into an APEX/SPIRO desolvator, using post-desolvator trace N₂ addition to boost sensitivity.

Nalgene polypropylene separatory funnels (1000mL) and Corning 50 mL conical centrifuge vials were cleaned by heated submersion for 2 days at 60 °C in 1M reagent grade HCl, followed by a bulk rinse and 4X individual rinse of each vial with pure distilled water. Each funnel and vial was then filled with trace metal clean dilute HCl (~0.01M HCl) and heated in the oven at 60 °C for one day on either end. Separatory funnels and centrifuge vials were kept filled until just before usage.

The separatory funnels were rinsed with distilled water after each use and then filled with high-purity distilled water spiked with high-purity HCl (final concentration ~0.01M) between uses.

Nobias Chelate PA1 resin was cleaned with 2 methanol rinses, distilled water rinse followed by leaching with ultrapure 6M HCl for 12-24 hours. This procedure was repeated twice, followed by two one-day leaches with ultrapure 3M HNO₃ on a shaker table. The resin was then rinsed six times with distilled water to removed the nitric acid. It was then leached twice with ultrapure 0.1N HNO₃ for one day each. The final 0.1N rinse was checked for Pb blank by ICPMS and the resin only used if the blank was acceptably low. Because of the large amounts of resin used, the used resin from each sample was saved and re-washed using the following protocol: leach with 3M HNO₃ for 1 day, rinse 4x with dH₂O, rinse with 0.1M HNO₃ for 2 days, rinse with fresh 0.1 M HNO₃ for 3 days, and then then rinse with dH₂O until the pH is ~5.

1000mL polypropylene separatory funnels (Nalgene) were weighed and rinsed one time with seawater sample, then filled with ~1000-1700 ml of sample. The pH of the solution was adjusted by addition of purified ammonium hydroxide/acetic acid pH=7.98 buffer (to a final pH>4; preferably pH~4.1 to keep the buffer blank low). A pre-cleaned aliquot of Nobias Chelate PA1 resin was added, and agitated on a shaker table for one day. Then the resin was allowed to settle to the bottom of the separatory funnel and drawn off into the 50 mL centrifuge tube. A second batch of Nobias Chelate PA1 resin was then added and agitated for one day on a shaker table. Then the second batch of resin was allowed to settle to the bottom

of the separatory funnel and drawn off into the same 50 mL centrifuge tube. The solution/precipitate mix was centrifuged and the supernatant solution siphoned off. Pb was released from the resin by addition of trace metal clean 0.1M HNO₃ for 1-2 days, then the supernatant was transferred into a clean fluorocarbon vial and taken to dryness on a hotplate in a clean flow fume hood in a positive pressure clean lab. A PA1 resin blank was taken from a batch of resin directly placed into the eluting 0.1M HNO₃ and henceforward treated as a sample.

Eichrom AG-1x8 resin was cleaned by three batch rinses with 6N trace metal clean HCl for a ~12 hours on a shaker table, followed by multiple washes with distilled water until the pH of the solution was above 4.5. Resin was stored at room temperature in the dark until use.

The residue from the samples and blanks was dissolved in 8 drops of high purity 1.1M HBr. The resin in the column was first cleaned with 6M HCl, equilibrated with 1.1M HBr, and then sample was loaded onto the column. The column was then washed with 1.1M HBr followed by 2M HCl and then eluted with 6M HCl. The samples in a 5 ml Savillex PTFE vial were then taken to dryness on a hotplate in a recirculating filtered air fume hood, and stored sealed until analysis.

Just before analysis, samples were dissolved for several minutes in 10ul concentrated ultrapure HNO₃. Then, an appropriate volume of ultrapure water was added (typically ~400ul) and spiked with an appropriate amount of Tl for mass fractionation correction. IsoProbe multicollector ICPMS Faraday cups were used to collect on ²⁰²Hg, ²⁰³Tl, ²⁰⁵Tl, ²⁰⁶Pb, ²⁰⁷Pb, and ²⁰⁸Pb. An Isotopx Daly detector with a WARP filter was used to collect on ²⁰⁴Pb+²⁰⁴Hg. This Daly detector is a revised version that eliminates a reflection problem with the electronic circuitry of the previous version. Because the deadtime of the Daly detector varied from day to day, we calibrated deadtime on each day by running a standard with known ²⁰⁶Pb/²⁰⁴Pb at a high 204 count rate. The counter efficiency drifts during the course of a day, so we established that drift by running a standard with known ²⁰⁶Pb/²⁰⁴Pb (and a 204 count rate comparable to the samples) every five samples. Tailing from one Faraday cup to the next was corrected by the ²⁰⁹Bi half-mass method as described by Thirlwall (2000).

On each analytical date, we calibrated the instrument by running NBS981 and normalized measured sample isotope ratios to our measured raw NBS981 isotope ratios to those established by Baker et al. (2004). Using this method for 22 determinations of an in-house standard ("BAB") shows that for samples near the upper range of the Pb signals shown for samples (~1V), ²⁰⁶Pb/²⁰⁷Pb and ²⁰⁸Pb/²⁰⁷Pb can be reproduced to ~200ppm. Low-level samples will be worse than that, but generally better than 1000ppm in this data set. Because of the drift uncertainty in the Daly detector, ²⁰⁶Pb/²⁰⁴Pb for samples in the mid-to-upper range of sample concentrations will be at best reproducible to ~500ppm. Zurbrick et al. (2018) discuss the reproducibility we observed for duplicate analyses of multiple samples as a function of the Pb sample size.

We have intercalibrated Pb isotope analyses with two labs as reported in Boyle et al. (2012). Since that report, two more labs have added intercalibration data. The outcome of that intercalibration suggests that the accuracy of our measurements approaches the analytical reproducibility we note above.

Processing Description

During the isotope ratio analysis, the data were collected in 20 cycles. The isotope ratios were edited for outliers, and averaged with internal standard errors estimated from the multiple cycles. This should be understood as the lower limit to the true error – the reported value cannot be any better than the internal reproducibility of the isotope run. Standard Ocean Data View flags were used (Reference all flags at https://www.bodc.ac.uk/data/codes_and_formats/odv_format/):

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.

There were a few points that fall off of the depth profiles 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).

Intercalibration Report:

Parallel samples from GN01 station Station 57 were collected (on two separate casts) at 21m, 85m, 445m, and 551m depth, with samples from one cast analyzed at MIT and the samples from the other cast analyzed at University of Toronto. The table below shows the comparison of the data (see supplemental file "GN01 Pb Isotopes Intercalibration Table"). Three out of four of the samples agree within 1000 ppm for $^{206}\text{Pb}/^{207}\text{Pb}$ and $^{208}\text{Pb}/^{206}\text{Pb}$, and within 5,000 ppm for $^{206}\text{Pb}/^{204}\text{Pb}$. Considering the extremely low Pb concentrations in these samples, this isotope ratio agreement is exceptional. It is likely that the one sample that does not agree within these limits was inadvertently contaminated.

BCO-DMO Processing:

- modified parameter names;
- formatted time as HHMM;
- added ISO8601 date/time format;
- 2020-11-04: replaced with GEOTRACES DOoR-formatted data.
- 2021-04-19: removed duplicate row for sample 11934.
- 2021-12-29: removed embargo on dataset.

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Supplemental Files

File
GN01 Pb Isotopes Intercalibration Table filename: Pb_Isotopes_Intercalibration.PNG (Portable Network Graphics (.png), 13.76 KB) MD5:944749b5d0268f2fc374774c18675817 <i>Comparison of Pb Isotope data from GN01 Station 57.</i>

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Related Publications

Baker, J., Peate, D., Waight, T., & Meyzen, C. (2004). Pb isotopic analysis of standards and samples using a ^{207}Pb – ^{204}Pb double spike and thallium to correct for mass bias with a double-focusing MC-ICP-MS. *Chemical Geology*, 211(3-4), 275–303. doi:[10.1016/j.chemgeo.2004.06.030](https://doi.org/10.1016/j.chemgeo.2004.06.030)
Methods

Boyle, E. A., John, S., Abouchami, W., Adkins, J. F., Echegoyen-Sanz, Y., Ellwood, M., ... Zhao, Y. (2012). GEOTRACES IC1 (BATS) contamination-prone trace element isotopes Cd, Fe, Pb, Zn, Cu, and Mo intercalibration. *Limnology and Oceanography: Methods*, 10(9), 653–665. doi:[10.4319/lom.2012.10.653](https://doi.org/10.4319/lom.2012.10.653)
Results

Cutter, G. A., & Bruland, K. W. (2012). Rapid and noncontaminating sampling system for trace elements in global ocean surveys. *Limnology and Oceanography: Methods*, 10(6), 425–436.
doi:[10.4319/lom.2012.10.425](https://doi.org/10.4319/lom.2012.10.425)
Methods

Planquette, H., & Sherrell, R. M. (2012). Sampling for particulate trace element determination using water sampling bottles: methodology and comparison to in situ pumps. *Limnology and Oceanography: Methods*, 10(5), 367–388. doi:[10.4319/lom.2012.10.367](https://doi.org/10.4319/lom.2012.10.367)

General

Reuer, M. K., Boyle, E. A., & Grant, B. C. (2003). Lead isotope analysis of marine carbonates and seawater by multiple collector ICP-MS. *Chemical Geology*, 200(1-2), 137–153. doi:10.1016/s0009-2541(03)00186-4
[https://doi.org/10.1016/S0009-2541\(03\)00186-4](https://doi.org/10.1016/S0009-2541(03)00186-4)

Methods

Thirlwall, M. (2001). Inappropriate tail corrections can cause large inaccuracy in isotope ratio determination by MC-ICP-MS. *Journal of Analytical Atomic Spectrometry*, 16(10), 1121–1125. doi:10.1039/b103828c <https://doi.org/10.1039/B103828C>

Methods

Zurbrick, C. M., Boyle, E. A., Kayser, R. J., Reuer, M. K., Wu, J., Planquette, H., ... Sarthou, G. (2018). Dissolved Pb and Pb isotopes in the North Atlantic from the GEOVIDE transect (GEOTRACES GA-01) and their decadal evolution. *Biogeosciences*, 15(16), 4995–5014. doi:[10.5194/bg-15-4995-2018](https://doi.org/10.5194/bg-15-4995-2018)

Results

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Parameters

Parameter	Description	Units
Cruise	Cruise identifier	unitless
SECT_ID	GEOTRACES cruise identifier	unitless
Station	Station number	unitless
CASTNO	Cast number	unitless
CTDPRS	CTD pressure	decibars
Depth	Sample depth	meters (m)
GEOTRC_EVENTNO	GEOTRACES event number	unitless
GEOTRC_SAMPNO	GEOTRACES sample number	unitless
Pb_206_207_D_RATIO_BOTTLE_mfvotq	Dissolved isotope ratio 206Pb/207Pb from seawater samples collected by Niskin bottle or other water sampling bottle	unitless
SE2_Pb_206_207_D_RATIO_BOTTLE_mfvotq	Standard error of Pb_206_207_D_RATIO_BOTTLE_mfvotq	unitless
Pb_208_207_D_RATIO_BOTTLE_gi07le	Dissolved isotope ratio 208Pb/207Pb from seawater samples collected by Niskin bottle or other water sampling bottle	unitless
SE2_Pb_208_207_D_RATIO_BOTTLE_gi07le	Standard error of Pb_208_207_D_RATIO_BOTTLE_gi07le	unitless
Pb_206_204_D_RATIO_BOTTLE_9fmkmm	Dissolved isotope ratio 206Pb/204Pb from seawater samples collected by Niskin bottle or other water sampling bottle	unitless
SE2_Pb_206_204_D_RATIO_BOTTLE_9fmkmm	Standard error of Pb_206_204_D_RATIO_BOTTLE_9fmkmm	unitless
Pb_ISOTOPE_FLAG	Quality flag for Pb isotope ratios	unitless

Pb_206_207_D_RATIO_BOAT_PUMP_ajqthu	Dissolved isotope ratio 206Pb/207Pb from seawater samples collected from a small boat using a pump	unitless
SE2_Pb_206_207_D_RATIO_BOAT_PUMP_ajqthu	Standard error of Pb_206_207_D_RATIO_BOAT_PUMP_ajqthu	unitless
Pb_208_207_D_RATIO_BOAT_PUMP_hu0wdq	Dissolved isotope ratio 208Pb/207Pb from seawater samples collected from a small boat using a pump	unitless
SE2_Pb_208_207_D_RATIO_BOAT_PUMP_hu0wdq	Standard error of Pb_208_207_D_RATIO_BOAT_PUMP_hu0wdq	unitless
Pb_206_204_D_RATIO_BOAT_PUMP_hcdnyx	Dissolved isotope ratio 206Pb/204Pb from seawater samples collected from a small boat using a pump	unitless
SE2_Pb_206_204_D_RATIO_BOAT_PUMP_hcdnyx	Standard error of Pb_206_204_D_RATIO_BOAT_PUMP_hcdnyx	unitless
Date	Sampling date; format: YYYYMMDD	unitless
Time	Sampling time; format: hhmm	unitless
LATITUDE	Latitude	degrees North
LONGITUDE	Longitude	degrees East
EXPOCODE	Cruise EXPOCODE	unitless
ISO_DateTime.UTC	Sampling data and time (UTC) formatted to ISO8601 standard: YYYY-MM-DDThh:mmZ	unitless

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Instruments

Dataset-specific Instrument Name	GV/Micromass IsoProbe multicollector ICPMS
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	Nobias Chelate PA1 preconcentration followed by anion exchange purification: This method starts with a new double batch ion-exchange chelation preconcentration followed by the Reuer et al. (2003) anion exchange purification followed by isotope ratio analysis on a GV/Micromass IsoProbe multicollector ICPMS.
Generic Instrument Description	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).

Dataset-specific Instrument Name	Teflon-coated GO-FLO bottles
Generic Instrument Name	GO-FLO Teflon Trace Metal Bottle
Dataset-specific Description	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
Generic Instrument Description	GO-FLO Teflon-lined Trace Metal free sampling bottles are used for collecting water samples for trace metal, nutrient and pigment analysis. The GO-FLO sampling bottle is designed specifically to avoid sample contamination at the surface, internal spring contamination, loss of sample on deck (internal seals), and exchange of water from different depths.

Dataset-specific Instrument Name	Isotopx Daly detector
Generic Instrument Name	Daly detector
Dataset-specific Description	An Isotopx Daly detector with a WARP filter was used to collect on $^{204}\text{Pb} + ^{204}\text{Hg}$.
Generic Instrument Description	The Daly detector was designed by N.R Daly in the 1960's. The design uses a conversion dynode to convert incident ions into electrons. It also separates the multiplication electronics away from the ion beam preventing secondary ion production on the multiplication dynodes.

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Deployments

HLY1502

Website	https://www.bco-dmo.org/deployment/638807
Platform	USCGC Healy
Report	https://datadocs.bco-dmo.org/docs/302/geotraces/GEOTRACES_ARCTIC/data_docs/cruise_reports/healy1502.pdf
Start Date	2015-08-09
End Date	2015-10-12
Description	Arctic transect encompassing Bering and Chukchi Shelves and the Canadian, Makarov and Amundsen sub-basins of the Arctic Ocean. The transect started in the Bering Sea (60°N) and traveled northward across the Bering Shelf, through the Bering Strait and across the Chukchi shelf, then traversing along 170-180°W across the Alpha-Mendeleev and Lomonosov Ridges to the North Pole (Amundsen basin, 90°N), and then back southward along ~150°W to terminate on the Chukchi Shelf (72°N). Additional cruise information is available in the GO-SHIP Cruise Report (PDF) and from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/HLY1502

Project Information

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

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

Coverage: Arctic Ocean; Sailing from Dutch Harbor to Dutch Harbor (GN01)

Description from NSF award abstract:

In pursuit of its goal "to identify processes and quantify fluxes that control the distributions of key trace elements and isotopes in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions", in 2015 the International GEOTRACES Program will embark on several years of research in the Arctic Ocean. In a region where climate warming and general environmental change are occurring at amazing speed, research such as this is important for understanding the current state of Arctic Ocean geochemistry and for developing predictive capability as the regional ecosystem continues to warm and influence global oceanic and climatic conditions. The three investigators funded on this award, will manage a large team of U.S. scientists who will compete through the regular NSF proposal process to contribute their own unique expertise in marine trace metal, isotopic, and carbon cycle geochemistry to the U.S. effort. The three managers will be responsible for arranging and overseeing at-sea technical services such as hydrographic measurements, nutrient analyses, and around-the-clock management of on-deck sampling activities upon which all participants depend, and for organizing all pre- and post-cruise technical support and scientific meetings. The management team will also lead educational outreach activities for the general public in Nome and Barrow, Alaska, to explain the significance of the study to these communities and to learn from residents' insights on observed changes in the marine system. The project itself will provide for the support and training of a number of pre-doctoral students and post-doctoral researchers. Inasmuch as the Arctic Ocean is an epicenter of global climate change, findings of this study are expected to advance present capability to forecast changes in regional and global ecosystem and climate system functioning.

As the United States' contribution to the International GEOTRACES Arctic Ocean initiative, this project will be part of an ongoing multi-national effort to further scientific knowledge about trace elements and isotopes in the world ocean. This U.S. expedition will focus on the western Arctic Ocean in the boreal summer of 2015. The scientific team will consist of the management team funded through this award plus a team of scientists from U.S. academic institutions who will have successfully competed for and received NSF funds for specific science projects in time to participate in the final stages of cruise planning. The cruise track segments will include the Bering Strait, Chukchi shelf, and the deep Canada Basin. Several stations will be designated as so-called super stations for intense study of atmospheric aerosols, sea ice, and sediment chemistry as well as water-column processes. In total, the set of coordinated international expeditions will involve the deployment of ice-capable research ships from 6 nations (US, Canada, Germany, Sweden, UK, and Russia) across different parts of the Arctic Ocean, and application of state-of-the-art methods to unravel the complex dynamics of trace metals and isotopes that are important as oceanographic and biogeochemical tracers in the sea.

Collaborative Research: GEOTRACES Arctic section: Spatial variability of lead concentrations and isotopic compositions in the western Arctic basins (GEOTRACES Arctic Pb)

Coverage: Arctic

NSF Award Abstract:

In this project, investigators participating in the 2015 U.S. GEOTRACES Arctic expedition will measure lead concentrations and isotopic compositions in seawater, snow, and aerosol samples collected in the western Arctic Ocean. In common with other national initiatives in the International GEOTRACES Program, the goals of the U.S. Arctic expedition are to identify processes and quantify fluxes that control the distributions of key trace elements and isotopes in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions. Some trace elements are essential to life, others are known biological toxins, and still others are important because they can be used as tracers of a variety of physical, chemical, and biological processes in the sea. Lead is an important substance to measure because it is a toxic trace element, ranked 2nd in the US Agency for Toxic Substances Disease Registry, and can be utilized as a tracer of ocean processes. The study will provide for the training and support of graduate and postdoctoral researchers.

Lead (Pb) is emitted into the atmosphere by high temperature industrial activities and leaded gasoline consumption and is globally dispersed by the atmosphere. High concentrations of Pb have been observed in Arctic ice cores and aerosols, and there are significant concerns about Pb, mercury, and other toxic trace elements in Arctic ecosystems. However, there remain significant questions about how these toxic trace elements and their isotopes currently exist in the Arctic, as well as how they will change in the future Arctic as a result of retreating summer sea ice and extensive drilling, mining, and industrialization. This proposal is aimed at remedying this deficiency in scientific knowledge by measuring Pb and Pb isotopes from seawater profiles, sea ice/seawater interface, snow and aerosols that will be collected during the U.S. GEOTRACES western Arctic transect. Specifically, researchers will gain knowledge on 1) the penetration of anthropogenic lead into the Arctic Ocean, 2) the primary sources of lead to surface waters, 3) the distributions of lead and their relation to scavenging processes and rates, 4) how the exchange with sinking particles contributes to lead's distribution, and 5) ocean circulation in the Arctic using lead as a tracer. Results from the study will have important implications for human health by increasing understanding of the distribution and abundance of a toxic trace element.

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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-1459287

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