Arsenic Speciation from the US GEOTRACES Arctic cruise (HLY1502, GN01) from August to October 2015

Website: https://www.bco-dmo.org/dataset/779098
Data Type: Cruise Results
Version: 1
Version Date: 2019-10-11

Project
» U.S. Arctic GEOTRACES Study (GN01) (U.S. GEOTRACES Arctic)
» GEOTRACES Arctic Section: Processes affecting the biogeochemical cycling of essential and toxic metalloids in the Arctic Ocean (GEOTRACES Arctic Arsenic and Selenium)

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

Contributors	Affiliation	Role
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Dataset Description

Data have been submitted to BCO-DMO and are currently being processed (2019-10-11).

Methods & Sampling

0.45 µm filtered seawater samples from the GEOTRACES Carousel/GO-FLO bottles were placed into 500 mL Teflon FEP bottles, refrigerated, and analyzed within 24 hours of collection.

Arsenic speciation was determined using selective hydride generation, liquid nitrogen-cooled trapping, and then revolatilization and determination with gas chromatography/photoionization detection (Cutter et al., 1991; Cutter and Cutter, 2006). Calibration performed daily via the standard additions method, with a minimum of 4 additions of AsIII and AsV. The slope from the linear fit to these data was then applied to all samples for that day. Detection limits were 0.03 nmol/L for As(III) and As(V). Precision was better than 8% RSD. Dimethyl and monomethyl arsenic (DMAS and MMAs) were simultaneously determined using the total inorganic As procedures above, but using a different gas chromatography column (15% OV-3 on Chromasorb W/AW DMCS, 80/100 mesh; Cutter and Cutter, 2006)). Detection limit for the methylated As species were 0.01 nmol/L and the precision was 6% (RSD) at 0.1 nmol/L. Calibration was performed using the standard additions method with a minimum of 4 additions of MMAs and DMAs. The slope from the linear fit to these data was then applied to all samples for that day.

Data Processing Description

Samples analyzed in triplicate and means computed. Standard additions of selenite were used for daily calibration on a representative sample and its slope applied to subsequent samples.

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Related Publications

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
Methods

Cutter, G. A., & Cutter, L. S. (2006). Biogeochemistry of arsenic and antimony in the North Pacific Ocean. Geochemistry, Geophysics, Geosystems, 7(5), n/a–n/a. doi:10.1029/2005gc001159
https://doi.org/10.1029/2005GC001159
Methods

Cutter, L. S., Cutter, G. A., & San Diego-McGlone, M. L. C. (1991). Simultaneous determination of inorganic arsenic and antimony species in natural waters using selective hydride generation with gas chromatography/photoionization detection. Analytical Chemistry, 63(11), 1138–1142. doi:10.1021/ac00011a015
Methods

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Parameters

Parameter	Description	Units
GEOTRC_SAMPNO	GEOTRACES sample number	unitless
Station	Station number	unitless
Depth	Sample depth	meters
As_III_D_CONC_BOTTLE	Arsenite, HAsO32-, AsIII	nanomoles per liter (nmol/L)
As_III_V_D_CONC_BOTTLE	Total inorganic As, As(III+V)	nanomoles per liter (nmol/L)
As_MM_D_CONC_BOTTLE	Monomethyl arsenic, MMAs	nanomoles per liter (nmol/L)
As_DM_D_CONC_BOTTLE	Dimethyl arsenic, DMAs	nanomoles per liter (nmol/L)

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Instruments

Dataset-specific Instrument Name	GEOTRACES Carousel/GO-FLO bottles
Generic Instrument Name	GO-FLO Bottle
Generic Instrument Description	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.

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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

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Project Information

U.S. Arctic GEOTRACES Study (GN01) (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 activites 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 globlal 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.

GEOTRACES Arctic Section: Processes affecting the biogeochemical cycling of essential and toxic metalloids in the Arctic Ocean (GEOTRACES Arctic Arsenic and Selenium)

NSF Award Abstract:
In this project, an investigator participating in the 2015 U.S. GEOTRACES Arctic expedition will establish the concentrations, chemical speciation, and cycling processes of arsenic and selenium in the Arctic Ocean. In common with other multinational 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. The metalloid elements arsenic and selenium to be studied in this project are toxic to many marine plants and animals, and their cycling in the Arctic is not well known. Thus, this project will have important implications for increased knowledge on the chemistry of these potentially toxic elements. Results from the project will be shared through outreach to Arctic residents and through a PolarTREC teacher who will participate in the cruise.

The metalloid elements arsenic and selenium have dynamic marine cycles that affect the microbiology of the water column and in turn are affected by it. Both exist in multiple oxidation states and inorganic and organic species within an oxidation state. This chemical speciation affects their reactivity and biotic uptake and toxicity. As shown in lower latitude waters, the concentration and speciation of dissolved arsenic can control the abundance and types of primary producers. In the Arctic virtually nothing is known about arsenic cycling, although there are possibly enhanced anthropogenic inputs from Canadian rivers and atmospheric deposition. In contrast, data from the high latitude North Pacific Ocean and Bering Sea strongly suggest that anthropogenic selenium from coal combustion is entering the Arctic and enriching its concentration in at least one top predator. The goal of this project is to qualitatively describe the input, removal, and internal cycling processes affecting the speciation and concentrations of arsenic and selenium, and determine rates of inputs and outputs of these processes using both direct measurements and computations. The study will greatly expand knowledge about arsenic and selenium cycling, with strong implications for the changing Arctic.

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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-1435708

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