

Aerosol lead (Pb) and Pb isotopes from Leg 1 (Seattle, WA to Hilo, HI) of the US GEOTRACES Pacific Meridional Transect (PMT) cruise (GP15, RR1814) on R/V Roger Revelle from September to October 2018

Website: <https://www.bco-dmo.org/dataset/934745>

Data Type: Cruise Results

Version: 1

Version Date: 2024-08-02

Project

- » [US GEOTRACES Pacific Meridional Transect \(GP15\)](#) (U.S. GEOTRACES PMT)
- » [Collaborative Research: US GEOTRACES PMT: Pb and Cr isotopes](#) (PMT Pb and Cr)

Program

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

Contributors	Affiliation	Role
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Abstract

Dr. Chris Marsay collected shipboard aerosol samples during the U.S. GEOTRACES GP15 Pacific Meridional Transect cruise on R/V Revelle from October to November 2018 and provided subsamples to Massachusetts Institute of Technology (MIT) for lead (Pb) and Pb isotope analyses. These were carried out by undergraduate student Avery Wang and Research Scientist Jahander Ramezani. The north-south transect shows large Pb concentration and Pb isotope changes. The Pb concentration variability is very similar to the Pb concentrations measured independently by Dr. Marsay. The Pb isotope ratios show a strong Chinese signature in the northern portion of the transect, and ratios more similar to American and Australian signatures further south.

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Coverage

Spatial Extent: N:54.66 E:-152 S:22 W:-155.17

Temporal Extent: 2018-09-30 - 2018-10-20

Methods & Sampling

The Pb sub-samples were collected by the group of Dr. Clifton Buck using the high-volume sampling system described by Morton et al. (2013). The sampling method and filter preparation are identical to that described in the "GEOTRACES Cookbook" (Cutter et al., 2014). The samples were sealed in clean plastic and shipped to MIT for analysis.

Pb isotopic measurements by the isotope dilution method were carried out using a ²⁰⁵Pb tracer solution (ET535) that was prepared and calibrated as part of the EARTHTIME project (Condon et al., 2015; McLean et al., 2015). These measurements were carried out by undergraduate student Avery Wang and Research Scientist Jahander Ramezani.

Filters were leached inside a Pb clean fluorocarbon vial with 0.1 M nitric acid at 100° Celsius for 24 hours. The solutions were taken to dryness, and then dissolved in 400 microliters (µL) of 1.1M HBr. Samples were purified by anion exchange chromatography on Eichrom AG-1x8 resin (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) using 1.1M HBr and 2M HCl to wash out impurities prior to collecting the sample with 6M HCl. Eluted samples were analyzed on a IsotopX Thermal Ionization Mass Spectrometer using repeated runs of standard NBS981 to account for mass fractionation.

Data Processing Description

Repeated runs of standard NBS981 were used to account for mass fractionation using the standard composition data of Baker et al. (2004).

BCO-DMO Processing Description

currently being processed

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Related Publications

Baker, J., Peate, D., Waight, T., & Meyzen, C. (2004). Pb isotopic analysis of standards and samples using a 207Pb–204Pb 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

Condon, D. J., Schoene, B., McLean, N. M., Bowring, S. A., & Parrish, R. R. (2015). Metrology and traceability of U–Pb isotope dilution geochronology (EARTHTIME Tracer Calibration Part I). *Geochimica et Cosmochimica Acta*, 164, 464–480. <https://doi.org/10.1016/j.gca.2015.05.026>

Methods

Cutter, G.A., Andersson, P., Codispoti, L., Croot, P., Francois, R., Lohan, M., Obata, H., van der Loeff, M. R. (2014) Sampling and Sample-Handling Protocols for GEOTRACES Cruises (cookbook) Version 2.0; December 2014.

http://www.geotraces.org/images/stories/documents/intercalibration/Cookbook_v2.pdf

Methods

McLean, N. M., Condon, D. J., Schoene, B., & Bowring, S. A. (2015). Evaluating uncertainties in the calibration of isotopic reference materials and multi-element isotopic tracers (EARTHTIME Tracer Calibration Part II). *Geochimica et Cosmochimica Acta*, 164, 481–501. <https://doi.org/10.1016/j.gca.2015.02.040>

Methods

Morton, P. L., Landing, W. M., Hsu, S.-C., Milne, A., Aguilar-Islas, A. M., Baker, A. R., ... Zamora, L. M. (2013). Methods for the sampling and analysis of marine aerosols: results from the 2008 GEOTRACES aerosol intercalibration experiment. *Limnology and Oceanography: Methods*, 11(2), 62–78. doi:[10.4319/lom.2013.11.62](https://doi.org/10.4319/lom.2013.11.62)

Methods

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Parameters

Parameter	Description	Units
Event_ID	Event ID number	unitless
Start_ISO_DateTime_UTC	Date and time (UTC) at start of the sample collection event	unitless

End_ISO_DateTime_UTC	Date and time (UTC) at end of the sample collection event	unitless
Start_Latitude	Latitude at start of event; negative values = South	decimal degrees
Start_Longitude	Longitude at start of event; negative values = West	decimal degrees
End_Latitude	Latitude at end of event; negative values = South	decimal degrees
End_Longitude	Longitude at end of event; negative values = West	decimal degrees
Rosette_Position	?	unitless
Sample_ID	GEOTRACES sample ID number	unitless
Pb_A_T_CONC_HIVOL_tsmsme	Total Pb concentration in aerosols (no preliminary leaching)	picomoles per cubic meter (pmol/m ³)
SD1_Pb_A_T_CONC_HIVOL_tsmsme	One standard deviation of Pb_A_T_CONC_HIVOL_tsmsme	picomoles per cubic meter (pmol/m ³)
Flag_Pb_A_T_CONC_HIVOL_tsmsme	ODV quality flag for Pb_A_T_CONC_HIVOL_tsmsme	unitless
Pb_206_207_A_T_RATIO_HIVOL_r8aus4	Atom ratio of given isotopes for total Pb referenced to {NBS981} in aerosols (no preliminary leaching)	unitless
SD1_Pb_206_207_A_T_RATIO_HIVOL_r8aus4	One standard deviation of Pb_206_207_A_T_RATIO_HIVOL_r8aus4	unitless
Flag_Pb_206_207_A_T_RATIO_HIVOL_r8aus4	ODV quality flag for Pb_206_207_A_T_RATIO_HIVOL_r8aus4	unitless
Pb_208_207_A_T_RATIO_HIVOL_ybtdvk	Atom ratio of given isotopes for total Pb referenced to {NBS981} in aerosols (no preliminary leaching)	unitless
SD1_Pb_208_207_A_T_RATIO_HIVOL_ybtdvk	One standard deviation of Pb_208_207_A_T_RATIO_HIVOL_ybtdvk	unitless
Flag_Pb_208_207_A_T_RATIO_HIVOL_ybtdvk	ODV quality flag for Pb_208_207_A_T_RATIO_HIVOL_ybtdvk	unitless

Pb_206_204_A_T_RATIO_HIVOL_w1gtye	Atom ratio of given isotopes for total Pb referenced to {NBS981} in aerosols (no preliminary leaching)	unitless
SD1_Pb_206_204_A_T_RATIO_HIVOL_w1gtye	One standard deviation of Pb_206_204_A_T_RATIO_HIVOL_w1gtye	unitless
Flag_Pb_206_204_A_T_RATIO_HIVOL_w1gtye	ODV quality flag for Pb_206_204_A_T_RATIO_HIVOL_w1gtye	unitless

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Instruments

Dataset-specific Instrument Name	High-volume aerosol sampling system onboard at sea
Generic Instrument Name	Aerosol Sampler
Dataset-specific Description	See Morton et al. 2013
Generic Instrument Description	A device that collects a sample of aerosol (dry particles or liquid droplets) from the atmosphere.

Dataset-specific Instrument Name	IsotopX IsoProbe-T Multicollector Thermal Ionization Mass Spectrometer
Generic Instrument Name	Thermal Ionization Mass Spectrometer
Generic Instrument Description	A Thermal Ionization Mass Spectrometer (TIMS) is an instrument that measures isotopic ratios after electrical excitation of a sample causes ionization of the isotopes.

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Deployments

RR1814

Website	https://www.bco-dmo.org/deployment/776913
Platform	R/V Roger Revelle
Report	https://datadocs.bco-dmo.org/docs/geotraces/GEOTRACES_PMT/casciotti/data_docs/GP15_Cruise_Report_with_ODF_Report.pdf
Start Date	2018-09-18
End Date	2018-10-21
Description	Additional cruise information is available from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/RR1814

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Project Information

US GEOTRACES Pacific Meridional Transect (GP15) (U.S. GEOTRACES PMT)

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

Coverage: Pacific Meridional Transect along 152W (GP15)

A 60-day research cruise took place in 2018 along a transect from Alaska to Tahiti at 152° W. A description of the project titled "*Collaborative Research: Management and implementation of the US GEOTRACES Pacific Meridional Transect*", funded by NSF, is below. Further project information is available on the [US GEOTRACES website](#) and on the [cruise blog](#). A detailed [cruise report is also available](#) as a PDF.

Description from NSF award abstract:

GEOTRACES is a global effort in the field of Chemical Oceanography in which the United States plays a major role. The goal of the GEOTRACES program is to understand the distributions of many elements and their isotopes in the ocean. Until quite recently, these elements could not be measured at a global scale. Understanding the distributions of these elements and isotopes will increase the understanding of processes that shape their distributions and also the processes that depend on these elements. For example, many "trace elements" (elements that are present in very low amounts) are also important for life, and their presence or absence can play a vital role in the population of marine ecosystems. This project will launch the next major U.S. GEOTRACES expedition in the Pacific Ocean between Alaska and Tahiti. The award made here would support all of the major infrastructure for this expedition, including the research vessel, the sampling equipment, and some of the core oceanographic measurements. This project will also support the personnel needed to lead the expedition and collect the samples.

This project would support the essential sampling operations and infrastructure for the U.S. GEOTRACES Pacific Meridional Transect along 152° W to support a large variety of individual science projects on trace element and isotope (TEI) biogeochemistry that will follow. Thus, the major objectives of this management proposal are: (1) plan and coordinate a 60 day research cruise in 2018; (2) obtain representative samples for a wide variety of TEIs using a conventional CTD/rosette, GEOTRACES Trace Element Sampling Systems, and in situ pumps; (3) acquire conventional CTD hydrographic data along with discrete samples for salinity, dissolved oxygen, algal pigments, and dissolved nutrients at micro- and nanomolar levels; (4) ensure that proper QA/QC protocols are followed and reported, as well as fulfilling all GEOTRACES intercalibration protocols; (5) prepare and deliver all hydrographic data to the GEOTRACES Data Assembly Centre (via the US BCO-DMO data center); and (6) coordinate all cruise communications between investigators, including preparation of a hydrographic report/publication. This project would also provide baseline measurements of TEIs in the Clarion-Clipperton fracture zone (~7.5°N-17°N, ~155°W-115°W) where large-scale deep sea mining is planned. Environmental impact assessments are underway in partnership with the mining industry, but the effect of mining activities on TEIs in the water column is one that could be uniquely assessed by the GEOTRACES community. In support of efforts to communicate the science to a wide audience the investigators will recruit an early career freelance science journalist with interests in marine science and oceanography to participate on the cruise and do public outreach, photography and/or videography, and social media from the ship, as well as to submit articles about the research to national media. The project would also support several graduate students.

Collaborative Research: US GEOTRACES PMT: Pb and Cr isotopes (PMT Pb and Cr)

NSF Award Abstract:

Most of the lead (Pb) in the ocean has been put there by human activities. These activities include high temperature industrial processes such as smelting, coal combustion, and incineration, as well as leaded gasoline consumption during the middle portion of the 20th century. Lead from these sources moves as fine particles around the world by the atmosphere's winds and eventually deposits on the surface ocean where it dissolves. Fortunately, it is possible to determine the different origins of these Pb sources (e.g. U.S., European, and Asian inputs) from its isotopic composition (isotopes are atoms of the same element with different numbers of neutrons in the nucleus). Lead has been shown to have different isotope ratios because the Pb has been extracted from mineral deposits from different geological periods. This project aims to determine how much of this Pb has moved into the deep North Pacific by ocean circulation or by attaching to sinking particles. This will be done by collecting seawater samples from the surface to the bottom of the ocean at about 30 stations between Tahiti and Alaska and analyzing these for their Pb concentration and Pb isotope ratios. This project will also determine variations in the chromium (Cr) isotope composition of Pacific seawater that are created when the lighter isotopes of Cr are selectively removed from the ocean in extremely low oxygen zones in the eastern tropical Pacific Ocean. This tool can help understand the ongoing evolution of decreasing oxygen in the ocean and past changes in the oxygen in the ocean established from geological archives such as sediments.

The first measurements of anthropogenic Pb in the ocean resulted in a profile in the North Pacific Ocean by Schaule and Patterson in 1981, and since then several labs have sparsely and erratically measured other profiles showing that the Pb in the Pacific Ocean is responding to regional changes in Pb fluxes - from the phasing out of leaded gasoline (mainly in Japan, Canada, Mexico, and the United States) to increasing amounts of coal combustion (mainly in China). The concentration of Pb decreased near Hawaii by a factor of two between 1981 and the present, and the

²⁰⁶Pb/²⁰⁷Pb isotopic composition of Pb decreased from ~1.20 (mainly U.S. Pb) to 1.165 (mainly Chinese coal Pb). The U.S. GEOTRACES Pacific Meridional Transect cruise will give us an unprecedented opportunity to obtain a detailed view of the penetration of anthropogenic Pb into the deep Pacific Ocean which can be used to determine the pathways that dissolved and particulate Pb take in arriving in the deep sea. This project will also determine the stable isotope composition of Cr, an element whose redox state is determined by the oxygen (O₂) concentration in the ocean. In oxygen deficient zones (ODZs) where [O₂] < 2 μmol/kg, Cr is reduced from chromate CrO₄²⁻ (hexavalent chromium) to Cr³⁺ ion (trivalent chromium). The isotopically lighter atoms of Cr are preferentially reduced, and the reduced Cr³⁺ ion is "particle-reactive" (attaches to sinking particles) and removed from the water column. That leaves the residual Cr isotopically heavier, so we can detect this process by measurements of ⁵³Cr/⁵²Cr. This process occurs in conjunction with nitrogen reduction (denitrification) and can be used to trace the consequences as ODZ waters mix out into the oxic ocean.

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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-1736996

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