Concentrations of dissolved aluminum (Al) in samples collected during the U.S. GEOTRACES EPZT cruise (R/V Thomas G. Thompson TN303) from October to December 2013

Website: https://www.bco-dmo.org/dataset/819735
Data Type: Cruise Results
Version: 1
Version Date: 2020-07-30

Project
» U.S. GEOTRACES East Pacific Zonal Transect (GP16) (U.S. GEOTRACES EPZT)
» US GEOTRACES Pacific Section-Shipboard Al, Mn and Fe (EPZT Shipboard Al Mn Fe)

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

Contributors	Affiliation	Role
Resing, Joseph A.	UW-NOAA Joint Institute for the Study of the Atmosphere and Ocean (JISAO)	Principal Investigator
Sedwick, Peter N.	Old Dominion University (ODU)	Co-Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract

Concentrations of dissolved aluminum in samples collected on the U.S. GEOTRACES EPZT cruise. These Al data were collected as a part of the US GEOTRACES EPZT cruise and were initially reported by Resing et al., (2015). Those data were analyzed and processed at sea. The data reported here have been corrected, based on reevaluating peak processing, drift corrections, and through the removal of errant data points. Additional missing data points have been also been added. Those data points are mostly from the Fish surface ocean sampler. These revised data are reported in Ho et al. (2019).

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Coverage

Spatial Extent: **N**:-10.1 **E**:-77.3761 **S**:-16.0006 **W**:-152.079
Temporal Extent: 2013-10-28 - 2013-12-17

Dataset Description

Concentrations of dissolved aluminum in samples collected on the U.S. GEOTRACES EPZT cruise. Note: These supersede the preliminary results of shipboard analyses listed as "Al_DISS" in the BCO-DMO file "CTD – GT-C Bottle".

These Al data were collected as a part of the US GEOTRACES EPZT cruise and were initially reported by Resing et al., (2015). Those data were analyzed and processed at sea. The data reported here have been corrected, based on reevaluating peak processing, drift corrections, and through the removal of errant data points. Additional missing data points have been also been added. Those data points are mostly from the Fish surface ocean sampler. These revised data are reported in Ho et al. (2019).

Methods & Sampling

Sample collection and processing:
Water column samples for trace metal analyses were obtained from two sampling devices, a CTD rosette package and a surface "fish" sampler. The Rosette package contained 24 modified 12 L GO-FLO bottles (General Oceanics) mounted on a trace-metal clean conductivity-temperature-depth (CTD) carousel (SeaBird) that was deployed on a Kevlar conducting cable (Cutter and Bruland, 2012). Upon recovery, the GO-FLO samplers were brought into a shipboard Class-100 clean laboratory container for sub-sampling. For filtered samples, the samplers were pressurized to 10 psi using filtered, compressed air, and the seawater samples were filtered through pre-cleaned 0.2 µm Acropak Supor capsule filters (Pall) (Cutter and Bruland, 2012). The fish sampler collected water from ~ 4m depth and pumped it into a clean van were it was filtered through pre-cleaned 0.2 µm Acropak Supor capsule filters. For dissolved aluminum (DAl), 918 samples were collected from all stations and depths. The 0.2 µm filtered subsamples were stored in 100 mL low density polyethylene (LDPE) bottles (Bel-Art) with LDPE caps and were acidified to pH ~1.7 with 12 N ultrapure hydrochloric acid (Fisher Optima).

Analytical methods:
DAl was determined at sea by flow injection analysis with in-line pre-concentration and fluorimetric detection (Resing and Measures, 1994). Method modifications included replacing resin-immobilized 8-hydroxyquinoline with Toyopearl AF-Chelate 650M, and using acidified de-ionized water as the carrier instead of acidified seawater. Daily precision for repeat analysis of internal and primary standards was ± 0.1 nM or 4.2%, whichever is larger. Two internal reference (IR1 and IR2) standards were run during the cruise, with DAl concentrations for IR1= 1.78 ± 0.27 nM (± 15%; n = 118) and and IR2 = 1.98 ± 0.07 nM (± 3.4%; n = 75), respectively. IR1 was run first and IR2 second with no overlap. The SAFe reference samples were analyzed simultaneously during sample analysis; SAFe S was 2.54 ± 0.16 nM (n = 34), SAFe D2 was 1.80 ± 0.18 nM (n = 33) and SAFe D1 was 1.40 ± 0.20 nM (n = 39). The internal standards, Geotraces reference materials, and other samples run throughout the cruise were used to correct for drift in the data. These corrections resulted in small overall changes in IR1 (1.67 ± 0.18 nM; ± 11%; n = 118), SAFe S (2.45 ± 0.14 nM; n = 34; consensus value = 1.74 ± 0.09 nM); for SAFe D2 (1.70 ± 0.14 nM; n = 33; consensus value 1.04 ± 0.1 nM); and for SAFe D1 (1.31 ± 0.13 nM; n = 39; consensus value = 0.64 nM). IR2 was run over a period of time with no observable drift and thus was not corrected. The least squares best fit between the average value for each standard versus the consensus values yielded DAlsample = 1.04 DAlGT + 0.63 nM ($r^2 = 0.99$). The overall regression for all 116 data points yielded DAlsample = 1.06 DAlGT + 0.62 nM ($r^2 = 0.92$). Prior to this cruise our laboratory produced DAl determinations that were statistically indistinguishable from the SAFe consensus concentrations. However since this cruise our values continue to be elevated compared to the consensus value. A similar offset has been communicated to me by another Geotraces scientist. It should be noted that these references samples are stored in LDPE bottles with HDPE lids, thus allowing for the possibility of contamination. Samples collected throughout the cruise (n=125) where run on different days and/or from different sample bottles to check for overall accuracy and precision. Some of these samples required drift correction some did not. The average absolute difference between these replicate analyses was 0.16nM. We also note that for seven samples collected in LDPE bottles with LDPE lids yielded Al concentrations statistically indistinguishable from those in LDPE bottles with Polypropylene lids with an average difference of 0.07nM. This is not surprising given the short contact time between the sample and the upright bottle.

These data will be submitted to the Intermediate Data Product (IDP) when the crossover data is available from the US Geotraces PMT cruise. The PI currently has the preliminary data is waiting for the analyses of those data to be completed.

Problem report:
The data reported here have been corrected, based on reevaluating peak processing, drift corrections, and through the removal of errant data points. Additional missing data points have been also been added. Those data points are mostly from the Fish surface-ocean sampler. The Al from Station 1 was revised, however the use of internal standards and replicate analyses was limited for these data.

Data Processing Description

BCO-DMO Processing:
- renamed fields;
- replaced missing data with 'nd' (no data);
- corrected issue in original data file where Al_D_CONC_BOTTLE_Error values were incorrectly placed in the Al_D_CONC_FISH_error column.

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Data Files

File
dissolved_Al.csv(Comma Separated Values (.csv), 73.07 KB) MD5:ba8e6f0efa4247be9e202c4cfb14d916 Primary data file for dataset ID 819735

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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

Ho, P., Resing, J. A., & Shiller, A. M. (2019). Processes controlling the distribution of dissolved Al and Ga along the U.S. GEOTRACES East Pacific Zonal Transect (GP16). Deep Sea Research Part I: Oceanographic Research Papers, 147, 128–145. doi:10.1016/j.dsr.2019.04.009
Results

Resing, J. A., & Measures, C. I. (1994). Fluorometric Determination of Al in Seawater by Flow Injection Analysis with In-Line Preconcentration. Analytical Chemistry, 66(22), 4105–4111. doi:10.1021/ac00094a039
Methods

Resing, J. A., Sedwick, P. N., German, C. R., Jenkins, W. J., Moffett, J. W., Sohst, B. M., & Tagliabue, A. (2015). Basin-scale transport of hydrothermal dissolved metals across the South Pacific Ocean. Nature, 523(7559), 200–203. doi:10.1038/nature14577
Results

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Parameters

Parameter	Description	Units
STNNBR	Station identifier for major stations	unitless
CASTNO	Number of hydrocast at given station	unitless
GEOTRC_SAMPNO	Geotraces sample number	unitless
GeoF_ID	Surface Fish sample number	unitless
CTDDEPTH	Depth that sample was collected at	meters (m)
Al_D_CONC_BOTTLE	Dissolved Aluminum in CTD bottles	nanomolar (nM)
Al_D_CONC_BOTTLE_Error	Estimated error of each Al_D_CONC_BOTTLE measurement	nanomolar (nM)
Al_D_CONC_FISH	Dissolved Aluminum in Surface Fish Samples	nanomolar (nM)
Al_D_CONC_FISH_error	Estimated error of each Al_D_CONC_FISH measurement	nanomolar (nM)
Flag	Data quality flag: 1 = Acceptable; 3 = questionable failed subjective tests	unitless
Latitude	Latitude	degrees North
Longitude	Longitude	degrees East
GEOTRC_EVENTNO	Sequential number assigned to each deployment or event	unitless
Deployment_type	Collection instrument; samples were collected from the Geotraces trace metal rosette or the surface "fish" sampler	unitless

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Instruments

Dataset-specific Instrument Name	flow injection analysis
Generic Instrument Name	Flow Injection Analyzer
Generic Instrument Description	An instrument that performs flow injection analysis. Flow injection analysis (FIA) is an approach to chemical analysis that is accomplished by injecting a plug of sample into a flowing carrier stream. FIA is an automated method in which a sample is injected into a continuous flow of a carrier solution that mixes with other continuously flowing solutions before reaching a detector. Precision is dramatically increased when FIA is used instead of manual injections and as a result very specific FIA systems have been developed for a wide array of analytical techniques.

Dataset-specific Instrument Name	surface "fish" sampler
Generic Instrument Name	GeoFish Towed near-Surface Sampler
Generic Instrument Description	The GeoFish towed sampler is a custom designed near surface (

Dataset-specific Instrument Name	GO-FLO bottles (General Oceanics)
Generic Instrument Name	GO-FLO Teflon Trace Metal Bottle
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.

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Deployments

TN303

Website	https://www.bco-dmo.org/deployment/499719
Platform	R/V Thomas G. Thompson
Report	http://dmoserv3.whoi.edu/data_docs/GEOTRACES/EPZT/GT13_EPZT_ODFReport_All.pdf
Start Date	2013-10-25
End Date	2013-12-20
Description	A zonal transect in the eastern tropical South Pacific (ETSP) from Peru to Tahiti as the second cruise of the U.S.GEOTRACES Program. This Pacific section includes a large area characterized by high rates of primary production and particle export in the eastern boundary associated with the Peru Upwelling, a large oxygen minimum zone that is a major global sink for fixed nitrogen, and a large hydrothermal plume arising from the East Pacific Rise. This particular section was selected as a result of open planning workshops in 2007 and 2008, with a final recommendation made by the U.S.GEOTRACES Steering Committee in 2009. It is the first part of a two-stage plan that will include a meridional section of the Pacific from Tahiti to Alaska as a subsequent expedition. Figure 1. The 2013 GEOTRACES EPZT Cruise Track. [click on the image to view a larger version] Additional cruise information is available from the Rolling Deck to Repository (R2R): http://www.rvdata.us/catalog/TN303

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Project Information

U.S. GEOTRACES East Pacific Zonal Transect (GP16) (U.S. GEOTRACES EPZT)

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

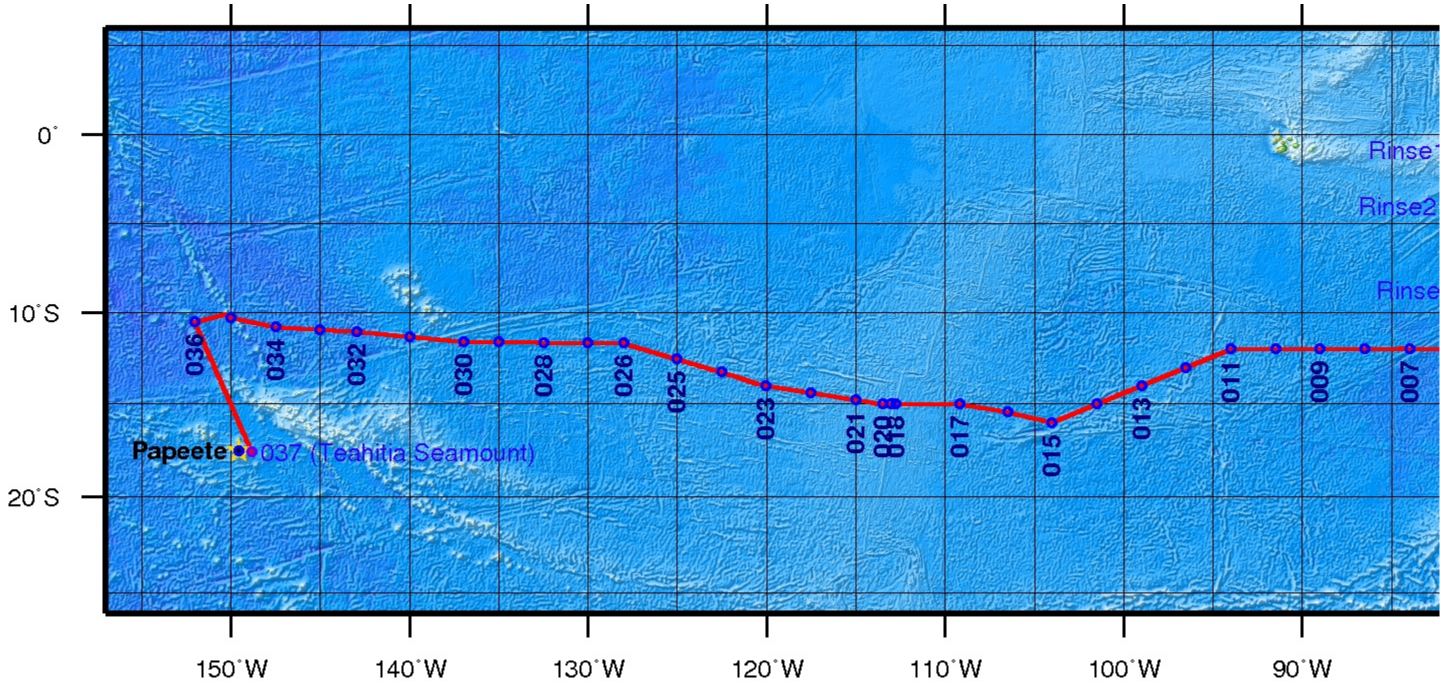
Coverage: Eastern Tropical Pacific - Transect from Peru to Tahiti (GP16)

From the NSF Award Abstract
The mission of the International GEOTRACES Program (https://www.geotraces.org/), of which the U.S. chemical oceanography research community is a founding member, is "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" (GEOTRACES Science Plan, 2006). In the United States, ocean chemists are currently in the process of organizing a zonal transect in the eastern tropical South Pacific (ETSP) from Peru to Tahiti as the second cruise of the U.S.GEOTRACES Program. This Pacific section includes a large area characterized by high rates of primary production and particle export in the eastern boundary associated with the Peru Upwelling, a large oxygen minimum zone that is a major global sink for fixed nitrogen, and a large hydrothermal plume arising from the East Pacific Rise. This particular section was selected as a result of open planning workshops in 2007 and 2008, with a final recommendation made by the U.S.GEOTRACES Steering Committee in 2009. It is the first part of a two-stage plan that will include a meridional section of the Pacific from Tahiti to Alaska as a subsequent expedition.

This award provides funding for management of the U.S.GEOTRACES Pacific campaign to a team of scientists from the University of Southern California, Old Dominion University, and the Woods Hole Oceanographic Institution. The three co-leaders will provide mission leadership, essential support services, and management structure for acquiring the trace elements and isotopes samples listed as core parameters in the International GEOTRACES Science Plan, plus hydrographic and nutrient data needed by participating investigators. With this support from NSF, the management team will (1) plan and coordinate the 52-day Pacific research cruise described above; (2) obtain representative samples for a wide variety of trace metals of interest using conventional CTD/rosette and GEOTRACES Sampling Systems; (3) acquire conventional JGOFS/WOCE-quality hydrographic data (CTD, transmissometer, fluorometer, oxygen sensor, etc) along with discrete samples for salinity, dissolved oxygen (to 1 uM detection limits), plant pigments, redox tracers such as ammonium and nitrite, 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-type data to the GEOTRACES Data Center (and US data centers); and (6) coordinate cruise communications between all participating investigators, including preparation of a hydrographic report/publication.

Broader Impacts: The project is part of an international collaborative program that has forged strong partnerships in the intercalibration and implementation phases that are unprecedented in chemical oceanography. The science product of these collective missions will enhance our ability to understand how to interpret the chemical composition of the ocean, and interpret how climate change will affect ocean chemistry. Partnerships include contributions to the infrastructure of developing nations with overlapping interests in the study area, in this case Peru. There is a strong educational component to the program, with many Ph.D. students carrying out thesis research within the program.

Figure 1. The 2013 GEOTRACES EPZT Cruise Track. [click on the image to view a larger version]



GEOTRACES-EPZT Cruise Track 2014-08-06 23:21 UTC

US GEOTRACES Pacific Section-Shipboard Al, Mn and Fe (EPZT Shipboard Al Mn Fe)

Coverage: Eastern South Pacific Ocean

Description from NSF award abstract:
The 2013 GEOTRACES Eastern Pacific Zonal transect cruise will transit from the highly productive coastal upwelling region off Peru to the stratified oligotrophic waters of the South Pacific subtropical gyre on its way to Tahiti. A range of subsurface oxygen depleted water and sedimentary inputs from the Peru margin will be encountered, as well as hydrothermal vents at 15°S on the East Pacific Rise (EPR). Scientists from the University of Washington and Old Dominion University plan to analyze seawater samples for dissolved and total-dissolvable aluminum (Al), manganese (Mn), and iron (Fe) in water column samples. The dissolved Al, Mn, and Fe in samples from the upper water column (<1000 m depth) will be analyzed onboard to ensure samples being collected are uncontaminated, as well as samples from west of the EPR at hydrothermal plume depths. The shipboard analyses will be augmented by shore-based analyses of water column samples from all depths, as well as analyses of total-dissolvable Al, Mn, and Fe, which will complement the direct analyses of particulate metals undertaken by other GEOTRACES investigators. Results will be used to test the following hypotheses concerning the sources and cycling of Al, Mn and Fe in the ocean: (1) when Aeolian inputs are relatively constant, dissolved Al concentrations in surface waters vary as a function of biological production; (2) concentration maxima of dissolved Al, Mn, and Fe in subsurface waters of the Eastern Pacific oxygen minimum zone are the result of lateral transport from the continental margin by means of resuspension and remobilization; and (3) values about ambient levels with conservative behavior will be encountered in the neutrally buoyant plume about the East Pacific Rise ridge crest for dissolved Fe and Al.

As regards broader impacts, results from the study would be disseminated to the public via lectures, the internet, and press releases. One graduate and one undergraduate student from the University of Washington would be supported and trained as part of this project.

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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-1237011
NSF Division of Ocean Sciences (NSF OCE)	OCE-1237034

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