Particulate iron (pFe) isotope concentrations from the GEOTRACES EPZT cruise (R/V Thomas G. Thompson TN303) in the Eastern Tropical Pacific from October to December 2013

Website: https://www.bco-dmo.org/dataset/669178
Data Type: Cruise Results
Version: 09 December 2016
Version Date: 2016-12-09

Project
» U.S. GEOTRACES East Pacific Zonal Transect (GP16) (U.S. GEOTRACES EPZT)
» GEOTRACES Pacific section: Dissolved Fe, Cd, and Zn isotopes (EPZT Diss Fe Zn Cd)
» Experimental constraints on marine Fe isotope effects - Biology, ligands, and particles (Fe isotope effects)

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

Contributors	Affiliation	Role
John, Seth G.	University of Southern California (USC)	Principal Investigator
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Coverage

Spatial Extent: **N**:-10.5 **E**:-77.38 **S**:-16 **W**:-152

Dataset Description

Particulate iron (pFe) isotope concentrations from the GEOTRACES EPZT cruise

Methods & Sampling

A subsample of 0.8 - 51 um-sized suspended particles collected using McLane in situ pumps was provided by P. Lam. Details of the sampling methodology are described in Ohnemus & Lam (2015). For a small number of samples, a low volume of seawater drawn through the filter resulted in unreliable data (see Data Processing).

The "labile" phase of the suspended particles was determined by leaching with a pH 8 solution of 0.1M oxalic acid and 0.05M EDTA for 2 hours at 90 C. Method is described in Revels et al (2015). Concentrations of Al, P, V, Mn, Fe, Co, Ni, Cu, Zn, Cd, Ba, Ce, La and Pb in the labile phase were determined by analysis of the leachate on a Thermo Scientific Element XR ICP-MS. Samples were run alongside blanks and standards prepared in the same matrix, with all samples, blanks and standards spiked with In as an internal standard. Repeat analyses of blanks and standards were carried out throughout analysis sequences as a further check on instrumental drift and reproducibility of data.

Aliquots of the leachate containing a known quantity of Fe were then spiked with an Fe-57-Fe-58 double-spike and purified by anion exchange chromatography and Fe concentration and d56Fe were measured by Thermo Neptune multi-collector ICP-MS. The method is fully described in Revels et al (2015).

References:
D.C. Ohnemus and P.J. Lam (2015) Cycling of lithogenic marine particles in the US GEOTRACES North Atlantic transect. Deep-Sea Research II 116, 283-302. doi:10.1016/j.dsr2.2014.11.019
B.N. Revels, D.C. Ohnemus, P.J. Lam, T.M. Conway, S.G. John (2015) The isotopic signature and distribution of particulate iron in the North Atlantic Ocean. Deep-Sea Research II 116, 321-331. doi:10.1016/j.dsr2.2014.12.004

Data Processing Description

Data Processing:
All concentration data has been corrected for "dipped filter" blanks – filters that were deployed on each cast but did not have any seawater pumped through them. For each element, concentrations from all dipped filter blanks were averaged. The median dipped filter blank has been subtracted from this data. The given uncertainties in concentration data were calculated by propagating uncertainties from instrument precision and the standard deviation of dipped filter blanks. Detection limits are defined as three times the standard deviation of the dipped filter blanks. Concentrations below detection limit are identified as "BDL".

Iron isotope measurements have been corrected for the leach reagent blank and uncertainties were calculated by an isotope mass balance equation involving the instrument precision and the mean and standard deviation of the reagent blank (equation 2 in Revels et al (2015)).

Data have been giving the following quality flags:
2 – good data
3 – suspect data
4 – bad data
5 – no data

BCO-DMO Processing:
- modified parameter names to conform with BCO-DMO and GEOTRACES naming conventions;
- replaced "<DL" with "BDL" (below detection limit);
- replaced missing data with "nd" (no data).

Additional GEOTRACES Processing:
As was done for the GEOTRACES-NAT data, 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:

cruise_id, EXPOCODE,SECT_ID, STNNBR, CASTNO, GEOTRC_EVENTNO, GEOTRC_SAMPNO, GEOTRC_INSTR, SAMPNO, GF_NO, BTLNBR, BTLNBR_FLAG_W, DATE_START_EVENT, TIME_START_EVENT, ISO_DATETIME_UTC_START_EVENT, EVENT_LAT, EVENT_LON, DEPTH_MIN, DEPTH_MAX, BTL_DATE, BTL_TIME, BTL_ISO_DATETIME_UTC, BTL_LAT, BTL_LON, ODF_CTDPRS, SMDEPTH, FMDEPTH, BTMDEPTH, CTDPRS, CTDDEPTH.

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 and ODF_Bottle datasets. Non-bottle parameters, including those from GeoFish tows, Aerosol sampling, and McLane Pumps, were taken from the TN303 Event Log (version 30 Oct 2014). Where applicable, pump information was taken from the PUMP_Nuts_Sals dataset.

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 names 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.

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Data Files

File
pFe_isotopes_joined.csv(Comma Separated Values (.csv), 103.13 KB) MD5:68a06ff0e1000633f5b9cbc6d46781e6 Primary data file for dataset ID 669178

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Parameters

Parameter	Description	Units
cruise_id	Cruise identification (TN303)	unitless
SECT_ID	Cruise section identifier; EPZT = GEOTRACES East Pacific Zonal Transect	unitless
STNNBR	Station number	unitless
lat_pi	Latitude of in situ pumps deployment; North is positive	decimal degrees
lon_pi	Longitude of in situ pumps deployment; East is positive	decimal degrees
GEOTRC_SAMPNO	Unique GEOTRACE sample identifier. Sample numbers were assigned to each sample, based on event number and deployment depth	unitless
GEOTRC_EVENTNO	GEOTRACES event number for in situ pumps deployment	unitless
CASTNO	Cast number of in situ pumps at each station	unitless
ISO_DATETIME_UTC_START_EVENT	Date and time, formatted to the ISO 8601 standard, at the start of the sampling event, according to the event log. Format: YYYY-MM-DDTHH:MM:SS[.xx]Z; joined from the BCO-DMO GEOTRACES EPZT master event file	unitless
depth_pi	Depth of in situ pump deployment	meters (m)
Fe_SPL_CONC_PUMP_Nep	Concentration of labile particulate iron (Fe), from Neptune ICPMS analysis	nanomolar (nM)
Fe_SPL_CONC_PUMP_Nep_ERR	Uncertainty in concentration of labile particulate Fe from Neptune ICPMS analysis	nanomolar (nM)
Fe_SPL_CONC_PUMP_Nep_FLAG	Quality flag for concentration of labile particulate Fe from Neptune ICPMS	unitless
Fe_56_SPL_DELTA_PUMP_Nep	Iron (Fe) stable isotope ratio for labile particulate Fe, from Neptune ICPMS analysis; units of per mil (o/oo) = (((54Fe/56Fe)sample/(54Fe/56Fe)IRMM-014)-1)*1000	per mil
Fe_56_SPL_DELTA_PUMP_Nep_ERR	Uncertainty in Fe stable isotope ratio for labile particulate Fe from Nepture ICPMS	per mil
Fe_56_SPL_DELTA_PUMP_Nep_FLAG	Quality flag for Fe stable isotope ratio for labile particulate Fe from Nepture ICPMS	unitless
Al_SPL_CONC_PUMP	Labile particulate aluminium (Al) concentration from Element ICPMS	picomolar (pM)
Al_SPL_CONC_PUMP_ERR	Uncertainty for labile particulate Al concentration from Element ICPMS	picomolar (pM)
Al_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate Al concentration from Element ICPMS	unitless
Mn_SPL_CONC_PUMP	Labile particulate manganese (Mn) concentration from Element ICPMS	picomolar (pM)

Mn_SPL_CONC_PUMP_ERR	Uncertainty for labile particulate Mn concentration from Element ICPMS	picomolar (pM)
Mn_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate Mn concentration from Element ICPMS	unitless
Fe_SPL_CONC_PUMP	Labile particulate iron (Fe) concentration from Element ICPMS	nanomolar (nM)
Fe_SPL_CONC_PUMP_ERR	Uncertainty for labile particulate Fe concentration from Element ICPMS	nanomolar (nM)
Fe_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate Fe concentration from Element ICPMS	unitless
Co_SPL_CONC_PUMP	Labile particulate cobalt (Co) concentration from Element ICPMS	picomolar (pM)
Co_SPL_CONC_PUMP_ERR	Uncertainty for labile particulate Co concentration from Element ICPMS	picomolar (pM)
Co_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate Co concentration from Element ICPMS	unitless
Ni_SPL_CONC_PUMP	Labile particulate nickel (Ni) concentration from Element ICPMS	picomolar (pM)
Ni_SPL_CONC_PUMP_ERR	Uncertainty for labile particulate Ni concentration from Element ICPMS	picomolar (pM)
Ni_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate Ni concentration from Element ICPMS	unitless
Cu_SPL_CONC_PUMP	Labile particulate copper (Cu) concentration from Element ICPMS	picomolar (pM)
Cu_SPL_CONC_PUMP_ERR	Uncertainty for labile particulate Cu concentration from Element ICPMS	picomolar (pM)
Cu_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate Cu concentration from Element ICPMS	unitless
Zn_SPL_CONC_PUMP	Labile particulate zinc (Zn) concentration from Element ICPMS	picomolar (pM)
Zn_SPL_CONC_PUMP_ERR	Uncertainity for labile particulate Zn concentration from Element ICPMS	picomolar (pM)
Zn_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate Zn concentration from Element ICPMS	unitless
Ba_SPL_CONC_PUMP	Labile particulate barium (Ba) concentration from Element ICPMS	nanomolar (nM)
Ba_SPL_CONC_PUMP_ERR	Uncertainty for labile particulate Ba concentration from Element ICPMS	nanomolar (nM)
Ba_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate Ba concentration from Element ICPMS	unitless
Ce_SPL_CONC_PUMP	Labile particulate cerium (Ce) concentration from Element ICPMS	picomolar (pM)
Ce_SPL_CONC_PUMP_ERR	Uncertainty for labile particulate Ce concentration from Element ICPMS	picomolar (pM)
Ce_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate Ce concentration from Element ICPMS	unitless
La_SPL_CONC_PUMP	Labile particulate lanthanum (La) concentration from Element ICPMS	picomolar (pM)
La_SPL_CONC_PUMP_ERR	Uncertainty for labile particulate La concentration from Element ICPMS	picomolar (pM)
La_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate La concentration from Element ICPMS	unitless
P_SPL_CONC_PUMP	Labile particulate P concentration from Element ICPMS	nanomolar (nM)
P_SPL_CONC_PUMP_ERR	Uncertainty for labile particulate P concentration from Element ICPMS	nanomolar (nM)
P_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate P concentration from Element ICPMS	unitless
V_SPL_CONC_PUMP	Labile particulate vanadium (V) concentration from Element ICPMS	picomolar (pM)
V_SPL_CONC_PUMP_ERR	Uncertainty for labile particulate V concentration from Element ICPMS	picomolar (pM)

V_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate V concentration from Element ICPMS	unitless
Cd_SPL_CONC_PUMP	Labile particulate cadmium (Cd) concentration from Element ICPMS	picomolar (pM)
Cd_SPL_CONC_PUMP_ERR	Uncertainty for labile particulate Cd concentration from Element ICPMS	picomolar (pM)
Cd_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate Cd concentration from Element ICPMS	unitless
Pb_SPL_CONC_PUMP	Labile particulate lead (Pb) concentration from Element ICPMS	picomolar (pM)
Pb_SPL_CONC_PUMP_ERR	Uncertainty for labile particulate Pb concentration from Element ICPMS	picomolar (pM)
Pb_SPL_CONC_PUMP_FLAG	Quality flag for labile particulate Pb concentration from Element ICPMS	unitless
comments	Comments on the samples	unitless

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Instruments

Dataset-specific Instrument Name	ICP-MS
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	Concentrations of Al, P, V, Mn, Fe, Co, Ni, Cu, Zn, Cd, Ba, Ce, La and Pb in the labile phase were determined by analysis of the leachate on a Thermo Scientific Element XR ICP-MS. Fe concentration and d56Fe were also measured by Thermo Neptune multi-collector ICP-MS.
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	McLane in situ pumps
Generic Instrument Name	McLane Pump
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.

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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)

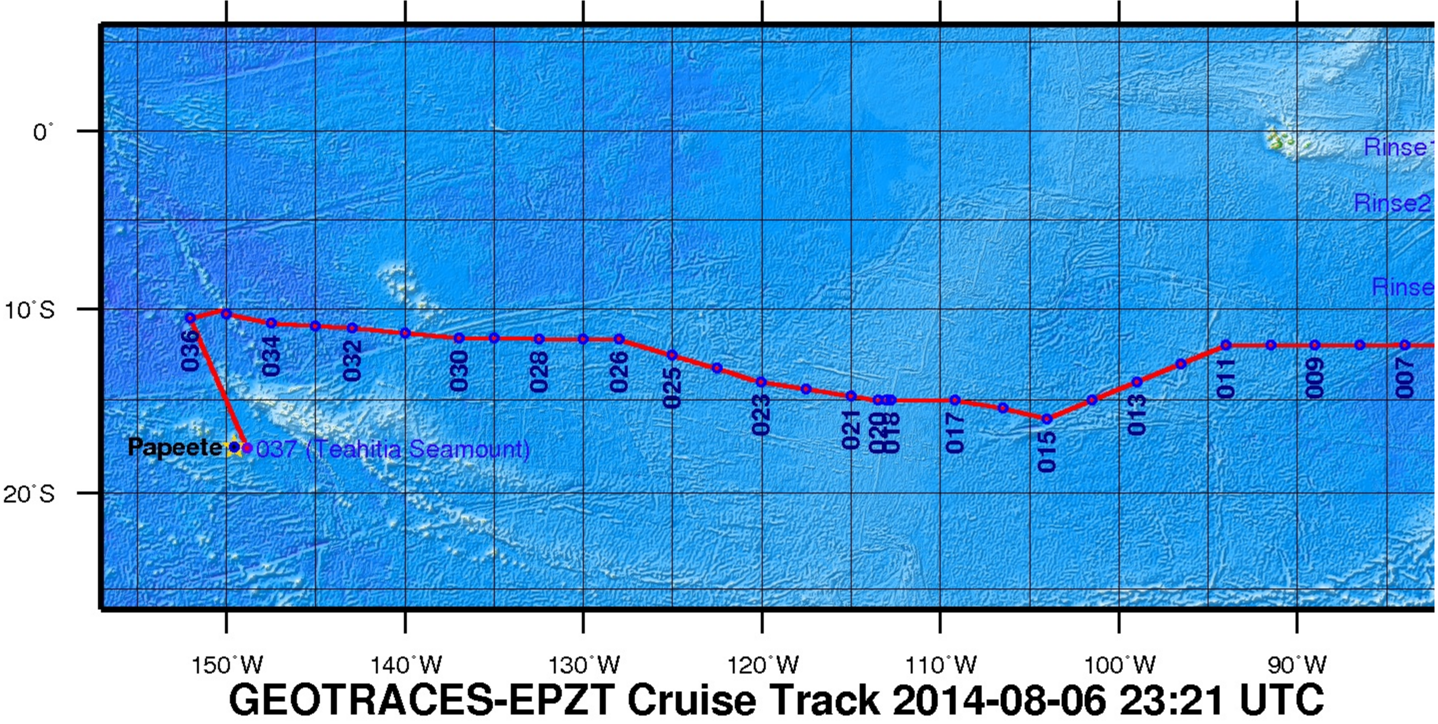
From the NSF Award Abstract
The mission of the International GEOTRACES Program (https://www.geotraces.org/), of which the U.S. chemical oceanography research community is a founding member, is "to identify processes and quantify fluxes that control the distributions of key trace elements and isotopes 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 Pacific section: Dissolved Fe, Cd, and Zn isotopes (EPZT Diss Fe Zn Cd)

Coverage: Eastern Tropical South Pacific

Extracted from the NSF award abstract:

Iron (Fe) and other trace metals have a profound impact on marine biogeochemistry. In about 20 to 50% of the world's oceans, primary productivity is limited because phytoplankton cannot obtain enough Fe to satisfy their physiological needs. Small changes in seawater Fe concentrations can therefore have an immense impact on the growth of phytoplankton, affecting the productivity of ecosystems and the sequestration of carbon in both the modern and ancient oceans. Other trace metals such as zinc (Zn), and cadmium (Cd) can be important nutrients for phytoplankton in their own right, and can be used as chemical tracers to explore processes such as nutrient supply and remineralization, ocean circulation, and earth's climate history.

In this project, a research team at the University of South Carolina at Columbia will measure dissolved Fe stable isotopes in samples collected on the US GEOTRACES Eastern Tropical South Pacific (ETSP) transect. GEOTRACES is an international effort to map the distribution of biogeochemically important metals in the oceans. Trace metal isotope ratios add a crucial dimension to the GEOTRACES mission because the information contained in isotope signals is often very different from what can be learned by concentration distributions alone. Along with Fe isotopes, they will simultaneously generate Cd and Zn isotope ratio data in some of the same samples. These data will be used to distinguish between competing hypotheses about trace-metal and nutrient distribution in the oceans, with a focus on two specific questions:

(1) What are the sources of bioavailable Fe to the oceans? Dust deposition, flux of reduced Fe from continental margin sediments, and hydrothermal vents have all been hypothesized as major contributors to the global dissolved Fe pool. The team will measure the stable Fe isotopic signatures of these fluxes at 'end-member' locations including surface waters (dust), the Peru oxygen minimum zone (reducing sediments), and the East Pacific Rise (hydrothermal vents). Basin-scale Fe isotopic distribution will then be studied in order to quantify how these various sources contribute to the global pool of biologically utilized Fe.

(2) What processes cycle Fe within the ocean? As Fe is cycled by various biological and inorganic processes, the team will track Fe isotopic composition in order to better understand how source-Fe isotopic signatures are modified through internal cycling, how iron is transferred between different pools such as dissolved and particulate phases, and the processes that allow dissolved and particulate Fe to become bioavailable.

Experimental constraints on marine Fe isotope effects - Biology, ligands, and particles (Fe isotope effects)

Coverage: Eastern Tropical Pacific

Extracted from the NSF award abstract:

Iron is an essential micronutrient for marine phytoplankton, which plays a key role in the global carbon cycle and marine ecosystems, and there is a need to better understand the sources and sinks of this essential micronutrient in the oceans. Iron isotopes are a recently developed tracer of iron biogeochemical cycling, and new iron isotope results indicate that iron-binding ligands may play a critical role in the isotopic fractionation of dissolved iron. At present, however, the quantitative importance of iron dissolution or biological iron uptake in the isotopic fractionation of dissolved iron in the oceans is not well-known. In this study, researchers from the University of South Carolina and the Bermuda Institute of

Ocean Sciences will collect and analyze samples from the Bermuda Atlantic Time-series Station (BATS) in order to; 1) measure the rate and isotope fractionation of iron dissolution from natural aerosols and oxic sediments in the presence of natural iron-binding ligands, and; 2) examine how phytoplankton fractionate iron isotopes during biological uptake. Results from this study will advance the development of iron isotopes as a tool for tracing iron biogeochemical cycling in the oceans.

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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-1649439
NSF Division of Ocean Sciences (NSF OCE)	OCE-1649435

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