pFe concentrations and isotopes of GP17-OCE

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Project
» Collaborative Research: US GEOTRACES GP17-OCE: Dissolved concentrations, isotopes, and colloids of the bioactive trace metals (GP17-OCE dissolved trace metals and their isotopes)

Contributors	Affiliation	Role
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Abstract
This dataset contains concentrations and isotopes of total and labile particulate iron (Fe) from pump samples. The samples were collected during the U.S. GEOTRACES GP17-OCE cruise aboard the R/V Roger Revelle (RR2214 from Dec 2022 to Jan 2023). The dataset also includes sample number, station number, latitude, longitude and depth.

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Coverage

Location: South Pacific and Southern Oceans (N:-19.89 E:-75.10 S:-67.01 W:-152.00)

Methods & Sampling

Sample source and treatment

Total phase

An aliquot (0.5 mL) of the total digest described in Ohnemus et al. (2015) were provided by D. Ohnemus and M. Ricci. 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 $d^{56}Fe$ were measured by Thermo Neptune Plus multi-collector ICP-MS.

Labile phase

A subsample of 0.8 - 51 um-sized suspended particles collected using McLane in situ pumps on the GP17-OCE cruise was provided by D. Ohnemus. 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 Fe in the labile phase were determined by analysis of the leachate on an Agilent 8900 QQQ ICPMS. 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 $d^{56}Fe$ were measured by Thermo Neptune Plus 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)).

All isotope data was reduced by using Excel 2016 with home-made data reduction algorithms following the iterative method described in Siebert et al. (2001)

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

Reference

Revels, B. N., Ohnemus, D. C., Lam, P. J., Conway, T. M., & John, S. G., 2015. The isotopic signature and distribution of particulate iron in the North Atlantic Ocean. Deep Sea Research Part II: Topical Studies in Oceanography, 116, 321–331. https://doi.org/10.1016/j.dsr2.2014.12.004

Siebert, C., Nägler, T.F., Kramers, J.D., 2001. Determination of molybdenum isotope fractionation by double-spike multicollector inductively coupled plasma mass spectrometry. Geochemistry, Geophysics, Geosystems 2. https://doi.org/10.1029/2000GC000124

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	Agilent 8900 QQQ ICP-MS
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Concentrations of Fe in the labile phase were determined by analysis of the leachate on an Agilent 8900 QQQ ICPMS.
Generic Instrument Description	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

Dataset-specific Instrument Name	Neptune Plus multi-collector ICP-MS (Thermo)
Generic Instrument Name	Thermo Fisher Scientific Neptune Plus inductively coupled plasma mass spectrometer
Dataset-specific Description	Used to measure Fe concentration and δ^{56}Fe isotope ratios for both total and labile particulate phases, following Fe-57-Fe-58 double-spiking and purification by anion exchange chromatography.
Generic Instrument Description	A laboratory high mass resolution inductively coupled plasma mass spectrometer (ICP-MS) designed for elemental and isotopic analysis. The instrument is based on a multicollector platform and combines the features of high mass resolution, variable multicollection and multiple ion counting (MIC). The Neptune Plus includes a Jet interface for increased sensitivity, a dual RPQ option and multiple discrete dynode electron multipliers for higher dynamic ranges, linearity and stability.

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Project Information

Collaborative Research: US GEOTRACES GP17-OCE: Dissolved concentrations, isotopes, and colloids of the bioactive trace metals (GP17-OCE dissolved trace metals and their isotopes)

The goal of the international GEOTRACES program is to understand the distributions of trace chemical elements and their isotopes in the oceans. Many trace metals, which are by definition present in very low amounts, are essential for life and thus considered nutrients for phytoplankton growth. Other elements can be useful for tracing other ocean processes, and some (such as lead) are important because they are pollutants. This project will address three main objectives: 1) to measure the dissolved concentrations and size partitioning of micronutrients iron, manganese, zinc, copper, cadmium, nickel, and pollutant lead in seawater from Tahiti towards Antarctica and then back northeast to South America; 2) to analyze the isotope ratios - the relative abundance of different forms of the same chemical element - of iron, zinc, cadmium, nickel, and copper in seawater, suspended particles, aerosols, and porewaters from this section, as isotopes provide diagnostic insights into sources, sinks, and metal transformations beyond what is provided by concentration measurements alone; and 3) to use ocean models to constrain the rates of ocean processes and effects of ocean circulation on trace metal and isotope distributions. This project spans three US labs, and four graduate

students and several undergraduate students will participate. It will also provide ultrafiltered samples and data to several other collaborating groups as a service.

The U.S. GEOTRACES GP17-OCE expedition, planned for late 2021 or 2022, aims to determine the distribution of trace elements and isotopes along a transect spanning regions of global importance to nutrient and carbon cycling, crossing the South Pacific Gyre, the iron-limited waters of the Antarctic Circumpolar Current, Pacific Deep Waters with hydrothermal inputs, and waters near the Chilean margin. The South Pacific Gyre and Pacific sector of the Southern Ocean are climate-critical regions for the transfer of heat, carbon, and nutrients within the global ocean, and they are a region where phytoplankton growth is typically limited by low concentrations of iron (Fe) in the surface ocean. The investigators will use a variety of analytical approaches, along with analyses made by other project collaborators, to address four major objectives related to dissolved micronutrient biogeochemistry in this region: 1) What are the relative fluxes of dissolved metals from dust, sediments, and Antarctic continental inputs to surface waters of the South Pacific gyre and ACC waters? 2) What fluxes of trace metals, especially Fe, are delivered by Pacific Deep Water to the Southern Ocean for upwelling to the surface waters? Are these fluxes hydrothermal or benthic in origin? Are dissolved metals supplied by the Pacific-Antarctic Ridge to the abyssal Southern Ocean? 3) How do micronutrient metal uptake stoichiometries change across gradients of primary production, community composition, and nutrient limitation from the gyre to ACC waters? How are these affected by metal speciation? 4) How do pre-formed biological signatures in surface waters, combined with regeneration and scavenging along the transport path, influence the regional and global distribution of TEIs?

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2049639

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