

Concentrations of dissolved cadmium, nickel, manganese, lanthanum, cerium, praseodymium, and neodymium from the Eastern Tropical North Pacific Ocean on R/V Revelle cruise RR1804-1805 (OMZ Nutrient Cycling project)

Website: <https://www.bco-dmo.org/dataset/872434>

Data Type: Cruise Results, experimental

Version: 1

Version Date: 2022-03-25

Project

» [The role of cryptic nutrient cycling within sinking particles on trace element transport in oxygen minimum zones](#) (OMZ Nutrient Cycling)

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Abstract

Oxygen deficient zones (ODZs) play an important role in the distribution and cycling of trace metals in the ocean, as important sources of metals including Fe and Mn to the ocean, and also as possible sinks of chalcophile elements such as Cd. The Eastern Tropical North Pacific (ETNP) ODZ is one of the three largest ODZs worldwide. Here we present results from two sectional surveys through the ETNP ODZ (23N-14N, 105W-130W) conducted during two cruises of the R/V Roger Revelle, RR1804 and RR1805, from March to April 2018, providing a high-resolution concentrations of dissolved Cd, Ni, Mn, La, Ce, Pr, and Nd in seawater.

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Coverage

Spatial Extent: N:26.96 E:-105.69 S:14 W:-128

Temporal Extent: 2018-04-16 - 2018-04-27

Methods & Sampling

Methodology:

Sampling and analytical procedures:

During RR1804 cruise, regular Niskin bottles (12 L GO-FLO bottles) and Seabird CTD rosette were used to collect seawater samples. Each seawater sample was collected into an acid-cleaned LDPE bottle on board and

then filtered in a trace metal clean (TMC) “bubble” on the boat using an AcroPak™ 0.2µm filter and a peristaltic pump and stored in 50 mL low density polyethylene (LDPE) centrifuge tubes.

During RR1805 cruise, the trace metal clean technique was used to collect seawater samples from the upper 700 m of the water column using 5 L acid-cleaned Teflon-coated external-spring “Niskin-type” bottles (Ocean Test Equipment) on a powder-coated trace metal clean rosette (Sea-Bird Electronics). After collection, seawater was filtered through acid-washed 47 mm diameter 0.2 µm Supor polyethersulfone filters (Pall) and collected into acid-washed 1L LDPE bottles (Nalgene).

Seawater samples were acidified to pH 2 with concentrated, distilled HCl (0.1% v/v) in the clean lab at University of Southern California (USC). After acidification, seawater samples were stored for three months before trace metal analysis.

Metal concentration analyses were identical to those used in Hawco et al. (2020). For each sample, 15 mL seawater was transferred to a 15 mL tube, then 50 µL of an isotope spike (containing ⁵⁷Fe, ⁶²Ni, ⁶⁵Cu, ⁶⁷Zn, ²⁰⁷Pb, and ¹¹⁰Cd) was added to the 15 mL tube and thoroughly mixed with the sample. The samples would then sit overnight before they were preconcentrated by seaFAST system. The seaFAST system helped to preconcentrate the seawater samples and remove the salt matrix. About 10 mL of seawater was injected through the Nobias PA-1 column of seaFAST and 0.5 mL eluent (1M HNO₃ containing 1 ppb In) was used to elute trace metals for concentration measurement. The trace metal concentrations were then measured by an Element 2 single collector sector field ICP-MS. Concentrations of Cd and Ni were derived by using an isotope dilution method. Concentrations of Mn and LREEs (La, Ce, Pr, and Nd) were quantified relative to the 10 ppb standard and corrected for incomplete sample loading using the recovery of Ni (Hawco et al., 2020). Trace metal concentrations were converted from nmol/L (or pmol/L) to nmol/kg (or pmol/kg) using a seawater density of 1.025 kg/L.

Data Processing Description

Researcher processing notes:

The data reduction algorithms are identical to those used in Hawco et. al. (2020), coded in Excel 2016.

BCO-DMO processing notes:

- Converted date format from %m/%d/%y to %Y-%m-%d
- Added a ISO formatted DateTime column

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Data Files

File
etnp_cd_ni_mn_lrees-1.csv (Comma Separated Values (.csv), 41.87 KB) MD5:cd451a639c5177e29da4030bb12bf166
Primary data file for dataset ID 872434

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Related Publications

Hawco, N. J., Yang, S.-C., Foreman, R. K., Funkey, C. P., Dugenne, M., White, A. E., Wilson, S. T., Kelly, R. L., Bian, X., Huang, K.-F., Karl, D. M., & John, S. G. (2020). Metal isotope signatures from lava-seawater interaction during the 2018 eruption of Kīlauea. *Geochimica et Cosmochimica Acta*, 282, 340-356.

<https://doi.org/10.1016/j.gca.2020.05.005>

Results

Parameters

Parameter	Description	Units
Cruise_id	Cruise identifier	unitless
Bottle	Bottle identifier	unitless
Station	Station identifier	unitless
Depth	Sample depth below the sea surface	meters (m)
Cd_TD_CONC_BOTTLE	Total dissolved Cd (<0.2 µm)	nanomoles per kilogram (nmol/kg)
Ni_TD_CONC_BOTTLE	Total dissolved Ni (<0.2 µm)	nanomoles per kilogram (nmol/kg)
Mn_TD_CONC_BOTTLE	Total dissolved Mn (<0.2 µm)	nanomoles per kilogram (nmol/kg)
La_TD_CONC_BOTTLE	Total dissolved La (<0.2 µm)	picomoles per kilogram (pmol/kg)
Ce_TD_CONC_BOTTLE	Total dissolved Ce (<0.2 µm)	picomoles per kilogram (pmol/kg)
Pr_TD_CONC_BOTTLE	Total dissolved Pr (<0.2 µm)	picomoles per kilogram (pmol/kg)
Nd_TD_CONC_BOTTLE	Total dissolved Nd (<0.2 µm)	picomoles per kilogram (pmol/kg)
Longitude	Longitude in decimal degrees East, west is negative	decimal degrees
Latitude	Latitude in decimal degrees North, north is positive.	decimal degrees
Date	Date (UTC) when sample was collected, in format %Y-%m-%d	unitless
Time.UTC	Start time (UTC) of sampling, in format %H:%M:%S	unitless
ISO_DateTime.UTC	Start datetime (UTC) of sampling, in format %Y-%m-%dT%H:%M:%SZ	unitless

Instruments

Dataset-specific Instrument Name	Powder-coated trace metal clean rosette (Sea-Bird Electronics)
Generic Instrument Name	CTD Sea-Bird
Dataset-specific Description	During RR1805 cruise, the trace metal clean technique was used to collect seawater samples from the upper 700 m of the water column using 5 L acid-cleaned Teflon-coated external-spring "Niskin-type" bottles (Ocean Test Equipment) on a powder-coated trace metal clean rosette (Sea-Bird Electronics).
Generic Instrument Description	A Conductivity, Temperature, Depth (CTD) sensor package from SeaBird Electronics. This instrument designation is used when specific make and model are not known or when a more specific term is not available in the BCO-DMO vocabulary. Refer to the dataset-specific metadata for more information about the specific CTD used. More information from: http://www.seabird.com/

Dataset-specific Instrument Name	ICP-MS (Thermo Element 2)
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Concentrations were determined using a high-resolution ICP-MS (Thermo Element 2) with a PC3 desolvation system.
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	5L "Niskin-type" bottles (Ocean Test Equipment)
Generic Instrument Name	Niskin bottle
Dataset-specific Description	During RR1805 cruise, the trace metal clean technique was used to collect seawater samples from the upper 700 m of the water column using 5 L acid-cleaned Teflon-coated external-spring "Niskin-type" bottles (Ocean Test Equipment) on a powder-coated trace metal clean rosette (Sea-Bird Electronics).
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

Dataset-specific Instrument Name	SeaFAST Automated Preconcentration System (Elemental Scientific)
Generic Instrument Name	SeaFAST Automated Preconcentration System
Dataset-specific Description	Preconcentration and purification of seawater were conducted using a seaFAST Automated Preconcentration System (Elemental Scientific).
Generic Instrument Description	The seaFAST is an automated sample introduction system for analysis of seawater and other high matrix samples for analyses by ICPMS (Inductively Coupled Plasma Mass Spectrometry).

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Deployments

RR1804

Website	https://www.bco-dmo.org/deployment/776766
Platform	R/V Roger Revelle
Start Date	2018-03-27
End Date	2018-04-13
Description	More information is available from R2R: https://www.rvdata.us/search/cruise/RR1804

RR1805

Website	https://www.bco-dmo.org/deployment/779193
Platform	R/V Roger Revelle
Start Date	2018-04-14
End Date	2018-05-02
Description	More information is available at R2R: https://www.rvdata.us/search/cruise/RR1805

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Project Information

The role of cryptic nutrient cycling within sinking particles on trace element transport in oxygen minimum zones (OMZ Nutrient Cycling)

Coverage: Eastern Tropical North Pacific

NSF Award Abstract:

The major process controlling the internal cycling of biologically active trace metals in the oceans is through uptake onto and remineralization from sinking particles. Uptake can occur through active biological uptake into living cells as micronutrients, or chemical adsorption onto sinking materials. This latter process is often referred to as scavenging. The relative importance of these processes is often unclear, especially for elements that are both biologically active and also "particle reactive." The latter characteristic is associated with sparing solubility in seawater and the formation of strong complexes with surface sites, with examples such as iron. Recent evidence suggests that the simplistic view of a sinking particle as a passive surface for metal complexation may require some revision. Investigators James Moffett and Seth John propose to study the

chemistry of transition metals within large sinking particles and the resultant effects on metal biogeochemical cycling. They will collaborate with a group at the University of Washington, recently funded to study the microbiology and molecular biology of these particles. The central hypothesis of this project is that reducing microbial microenvironments within large particles support high rates of nitrogen and sulfur cycling, greatly enhancing the particles' influence on metal chemistry. The investigators will study these processes in the Eastern Tropical North Pacific Oxygen Minimum Zone (OMZ). This regime was selected because of the wide range of redox conditions in the water column, and strong preliminary evidence that microenvironments within sinking particles have major biogeochemical impacts.

The primary objective is to investigate the interactions of metals with particles containing microenvironments that are more highly reducing than the surrounding waters. Such microenvironments arise when the prevailing terminal electron acceptor (oxygen, or nitrate in oxygen minimum zones) becomes depleted and alternative terminal electron acceptors are utilized. Within reducing microenvironments metal redox state and coordination chemistry are different from the bulk water column, and these microenvironments may dominate metal particle interactions. For example, reduction of sulfate to sulfide could bind metals that form strong sulfide complexes, such as cadmium and zinc, processes previously thought to be confined to sulfidic environments. Reducing microenvironments may account for the production of reduced species such as iron(II), even when their formation is thermodynamically unfavorable in the bulk water column. Tasks include observational characterization of dissolved and particulate trace metals and stable isotopes in the study area, sampling and in situ manipulation of particles using large-dimension sediment traps, shipboard experimental incubations under a range of redox conditions, and modeling, providing insight from microscopic to global scales. The metal chemistry data will be interpreted within a rich context of complimentary data including rates of nitrogen and sulfur cycling, phylogenetics and proteomic characterization of the concentration of key enzymes. Broader impacts include training of a postdoctoral scientist, international collaborations with Mexican scientists, and involvement of undergraduate students in the research.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1636332

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