Water column nitrate+nitrite d15N and d18O and total dissolved nitrogen d15N measurements from R/V Ka`imikai-O-Kanaloa cruise KOK1806 (HOT LAVA) in July 2018

Website: https://www.bco-dmo.org/dataset/770818
Data Type: Cruise Results
Version: 1
Version Date: 2019-06-18

Project
» Quantifying nitrogen fixation along unique geochemical gradients in the southwest Pacific Ocean (SW Pac N2 fixation)

Contributors	Affiliation	Role
Knapp, Angela N.	Florida State University (FSU)	Principal Investigator
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Abstract
This data set includes water column nitrate+nitrite and total dissolved nitrogen d15N measurements. These measurements were used to address the source of nitrate+nitrite in surface waters observed after the 2018 Kilauea eruption entered the ocean, leading to enhanced surface ocean chlorophyll. The results are consistent with an upwelling source of nitrate+nitrite from ~400 m driven by hot lava entering the ocean, leading to increased buoyancy of waters, driving "roils" (see F. J. Sansone, and J. A. Resing, 1995, J. Geophys. Res. Oceans). These data are also used as evidence that biological nitrogen fixation did not contribute to the nitrate+nitrite observed in surface waters.

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Coverage

Spatial Extent: **N**:19.45 **E**:-154.71 **S**:19.373 **W**:-154.829
Temporal Extent: 2018-07-14

Dataset Description

This results of this dataset are published in Wilson *et al.,* 2019

This data set includes water column nitrate+nitrite and total dissolved nitrogen d15N measurements. These measurements were used to address the source of nitrate+nitrite in surface waters observed after the 2018 Kilauea eruption entered the ocean, leading to enhanced surface ocean chlorophyll. The results are consistent with an upwelling source of nitrate+nitrite from ~400 m driven by hot lava entering the ocean, leading to increased buoyancy of waters, driving "roils" (see F. J. Sansone, and J. A. Resing, 1995, J. Geophys. Res. Oceans). These data are also used as evidence that biological nitrogen fixation did not contribute to the nitrate+nitrite observed in surface waters.

Methods & Sampling

Some water samples were collected by Niskin bottle on a CTD rosette ("CTD profile"), while others were collected using a trace metal clean "Towfish" that was running along side the ship and collected trace metal clean underway samples ~1 m below the sea surface.

NO3-+NO2- d15N and d18O and TDN δ15N analysis was by the "denitrifier method" and followed the methods described by Sigman et al., 2001, Casciotti et al., 2002, McIlvin and Casciotti, 2011, and Weigand et al., 2016. Briefly, NO3-+NO2- was quantitatively reduced to N2O by Pseudomonas aureofaciens and Pseudomonas chlororaphis, which was then cryogenically focused and analyzed on an isotope ratio mass spectrometer. A volume of sample was added to each bacterial vial to achieve a final quantity of 10 or 20 nmols N2O, which was then purged from the vial using a helium carrier gas. The d15N of N2O in samples was calibrated with the international isotopic reference materials

The δ15N of TDN was measured using persulfate oxidation of DON to NO3- followed by the denitrified method as described in Knapp et al. (2005).

Nitrate+nitrite concentration was measured by others (Karl lab, U. Hawaii) using colorimetric methods, and total dissolved nitrogen concentration was measured by others (Karl lab, U. Hawaii) using uv-oxidation and subsequent colorimetric analysis. Both of these data sets can be found at: http://scope.soest.hawaii.edu/data/

Data Processing Description

BCO-DMO Processing:
- modified parameter names (replaced spaces w/ underscores, shortened "D. Karl/Hawaii" to "Karl"),
- re-formatted date to yyyy-mm-dd (was m/dd/yyyy),
- replaced "no data" with "nd".

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Data Files

File
HOT_LAVA_nitrogen.csv (Comma Separated Values (.csv), 2.58 KB) MD5:25faa01d0f06b297ec5af04f7f07ca2c Primary data file for dataset ID 770818

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Related Publications

Casciotti, K. L., Sigman, D. M., Hastings, M. G., Böhlke, J. K., & Hilkert, A. (2002). Measurement of the Oxygen Isotopic Composition of Nitrate in Seawater and Freshwater Using the Denitrifier Method. Analytical Chemistry, 74(19), 4905–4912. doi:10.1021/ac020113w
Methods

Knapp, A. N., Sigman, D. M., & Lipschultz, F. (2005). N isotopic composition of dissolved organic nitrogen and nitrate at the Bermuda Atlantic Time-series Study site. Global Biogeochemical Cycles, 19(1). doi:10.1029/2004gb002320
Methods

McIlvin, M. R., & Casciotti, K. L. (2011). Technical Updates to the Bacterial Method for Nitrate Isotopic Analyses. Analytical Chemistry, 83(5), 1850–1856. doi:10.1021/ac1028984
Methods

Sansone, F. J., & Resing, J. A. (1995). Hydrography and geochemistry of sea surface hydrothermal plumes resulting from Hawaiian coastal volcanism. Journal of Geophysical Research, 100(C7), 13555.

doi:10.1029/95jc01120 https://doi.org/10.1029/95JC01120
Methods

Sigman, D. M., Casciotti, K. L., Andreani, M., Barford, C., Galanter, M., & Böhlke, J. K. (2001). A Bacterial Method for the Nitrogen Isotopic Analysis of Nitrate in Seawater and Freshwater. Analytical Chemistry, 73(17), 4145–4153. doi:10.1021/ac010088e
Methods

Weigand, M. A., Foriel, J., Barnett, B., Oleynik, S., & Sigman, D. M. (2016). Updates to instrumentation and protocols for isotopic analysis of nitrate by the denitrifier method. Rapid Communications in Mass Spectrometry, 30(12), 1365–1383. doi:10.1002/rcm.7570
Methods

Wilson, S. T., Hawco, N. J., Armbrust, E. V., Barone, B., Björkman, K. M., Boysen, A. K., … Karl, D. M. (2019). Kīlauea lava fuels phytoplankton bloom in the North Pacific Ocean. Science, 365(6457), 1040–1044. doi:10.1126/science.aax4767
Results

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Parameters

Parameter	Description	Units
Station_Number	Station number	unitless
Towfish_or_CTD_profile_station	Sampling system (either towfish or CTD rosette)	unitless
Depth	Sample depth	meters (m)
Date	Date of collection. Format: yyyy-mm-dd	unitless
Lat_N	Latitude North	degrees
Longitude_E	Longitude East	degrees
Karl_HI_NO3_NO2	Nitrate+nitrite concentration; measured in Karl lab at U. Hawaii using colorimetric methods	micromolar (uM)
Knapp_NO3_NO2_d15N	Nitrate+nitrite d15N	per mil
Knapp_NO3_NO2_d15N_std_dev	Standard deviation of Knapp_NO3_NO2_d15N	per mil
Knapp_NO3_NO2_d18O	Nitrate+nitrite d18O	per mil
Knapp_NO3_NO2_d18O_std_dev	Standard deviation of Knapp_NO3_NO2_d18O	per mil
Karl_TDN	Total dissolved nitrogen concentration; measured in Karl lab at U. Hawaii using uv-oxidation and subsequent colorimetric analysis	micromolar (uM)
Knapp_TDN_d15N	Total dissolved nitrogen ?15N	per mil
Knapp_TDN_d15N_std_dev	Standard deviation of Knapp_TDN_d15N	per mil

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Instruments

Dataset-specific Instrument Name	Towfish
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	Thermo Finnigan Delta V
Generic Instrument Name	Isotope-ratio Mass Spectrometer
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	Niskin bottle (CTD rosette)
Generic Instrument Name	Niskin bottle
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.

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Deployments

KOK1806

Website	https://www.bco-dmo.org/deployment/770816
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://datadocs.bco-dmo.org/docs/SW_Pac_N2_fixation/data_docs/KOK1806_cruise_report.pdf
Start Date	2018-07-13
End Date	2018-07-17
Description	See additional cruise information from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/KOK1806

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Project Information

Quantifying nitrogen fixation along unique geochemical gradients in the southwest Pacific Ocean (SW Pac N2 fixation)

Website: http://scope.soest.hawaii.edu/data/lava/lava.html

Coverage: Southwest Pacific Ocean between New Caledonia and Tahiti along ~18 deg S

NSF Award Abstract:
The availability of nitrogen in the surface ocean plays a critical role regulating rates of primary productivity in the ocean, and thus through modification of the carbon cycle, nitrogen has the capacity to influence climate.

The dominant source of biologically available nitrogen to the ocean is through a process known as di-nitrogen (N2) fixation, which involves the reduction of N2 gas dissolved in seawater to ammonium by microbes referred to as diazotrophs. While significant progress has been made identifying a diversity of marine diazotrophs in recent years using molecular tools, quantifying global rates of N2 fixation, and identifying which ocean basin supports the highest fluxes, has remained a vexing question. This research will quantify rates of N2 fixation as well as its importance for supporting production in the southwest Pacific Ocean. Results from this research will shed light on the sensitivities of N2 fixation (temperature, iron concentrations) as well as the extent of spatial and temporal coupling of nitrogen sources and sinks in the ocean. The work will be carried out by an early career scientist, and involve mentoring of young women, middle school girls and minorities, training of undergraduate and graduate researchers, and international collaborations.

Identifying the spatial distribution of the largest di-nitrogen (N2) fixation fluxes to the ocean remains a critical goal of chemical oceanography. The spatial distribution can inform our understanding of the environmental sensitivities of N2 fixation and the capacity for the dominant marine nitrogen (N) source and sink processes to respond to each other and thus influence the global carbon cycle and climate. In addition to temperature, two factors are at the heart of the current debate over what influences the spatial distribution of N2 fixation in the ocean: 1) the presence of adequate iron to meet the needs of N2 fixing microbes, and, 2) the absolute concentrations as well as ratios of surface ocean nitrate and phosphate concentrations that are low relative to the "Redfield" ratio, which are thought to favor N2 fixing microbes. This project will test the effects of gradients in atmospheric dust deposition on N2 fixation rates when surface waters have relatively constant but favorable nitrate to phosphate concentrations. The work will be carried out in the southwest Pacific, a region highlighted by new modeling work for its unique geochemical characteristics that are expected to favor significant N2 fixation fluxes. Nitrate+nitrite d15N as well as total dissolved nitrogen (TDN) concentration and d15N will be measured in water column samples collected on a French cruise and sediment traps were deployed to capture the sinking particulate N flux. The results will be compared with published work to evaluate which ocean regions support the largest N2 fixation fluxes.

More information:

This project was part of the Oligotrophy to UlTra-oligotrophy PACific Experiment (OUTPACE) cruise in the Southwest Pacific between New Caledonia (166°28' E; 22°14' S) and Tahiti (149°36' W; 17°34' S) 0-2000 m
* OUTPACE cruise (doi: http://dx.doi.org/10.17600/15000900)
* OUTPACE website: https://outpace.mio.univ-amu.fr/?lang=en

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1537314

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