Size-fractionated zooplankton d15N from net tows on R/V S.A. Agulhas II cruises VOY016 and VOY019 in the Southern Ocean south of Africa during 2015-2016

Website: https://www.bco-dmo.org/dataset/805737
Data Type: Cruise Results
Version: 1
Version Date: 2020-03-10

Project
» High-resolution, Assemblage-specific Records of Diatom-bound N Isotopes from the Indian Sector of the Antarctic Ocean (Diatom-bound_N_Isotopes)
» Understanding the nitrogen isotopes of planktonic foraminifera: A modern Sargasso Sea study (N Isotopes Foraminifera)
» MRI: Acquisition of Stable Isotope Instrumentation for the Biogeosciences at Princeton University (stable isotope instrumentation)

Contributors	Affiliation	Role
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Abstract
This dataset contains N isotope measurements of the different size-fractions of zooplankton collected by net tows.

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Coverage

Spatial Extent: **N**:-40.9588 **E**:38.4761 **S**:-53.9942 **W**:0.0416
Temporal Extent: 2015-07-27 - 2016-05-09

Dataset Description

This dataset contains N isotope measurements of the different size-fractions of zooplankton collected by net tows.

Methods & Sampling

Zooplankton were collected by towing a 200-µm-mesh plankton net for 90 min at a target depth within the mixed layer. Tow material was then sieved into the following size fractions: <150, 150-250, 250-500, 500-

1000, 1000-2000, 2000-5000 and >5000 µm. Each size-fraction was then filtered down onto a pre-combusted 0.7-µm-pore-size GF/F and frozen at −20°C for elemental and isotopic analysis.

The N isotope composition of size-fractionated zooplankton samples were measured at the University of Cape Town using a Thermo Scientific FLASH 2000 elemental analyzer coupled to a Thermo Scientific Delta V Plus mass spectrometer.

See methods section of Smart et al. (2020) for more detail.

Data Processing Description

N isotope measurements were referenced to atmospheric N_2 using three in-house organic standards: Choc, Merck Gel and Valine. Samples that contained GF/F material were additionally corrected for the contribution of the N blank associated with the filter paper.

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Data Files

File
zoop_N.csv (Comma Separated Values (.csv), 16.50 KB) MD5:5e393c0ccfed1b59ea9d5216e25df218 Primary data file for dataset ID 805737

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Related Publications

Smart, S. M., Fawcett, S. E., Ren, H., Schiebel, R., Tompkins, E. M., Martínez-García, A., … Sigman, D. M. (2020). The Nitrogen Isotopic Composition of Tissue and Shell-Bound Organic Matter of Planktic Foraminifera in Southern Ocean Surface Waters. Geochemistry, Geophysics, Geosystems, 21(2). doi:10.1029/2019gc008440 https://doi.org/10.1029/2019GC008440
Results

Smart, S. M., Ren, H., Fawcett, S. E., Schiebel, R., Conte, M., Rafter, P. A., … Sigman, D. M. (2018). Ground-truthing the planktic foraminifer-bound nitrogen isotope paleo-proxy in the Sargasso Sea. Geochimica et Cosmochimica Acta, 235, 463–482. doi:10.1016/j.gca.2018.05.023
General

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Parameters

Parameter	Description	Units
cruise	Cruise identifier	unitless
ship	Ship name	unitless
tow	Tow number	unitless

date	Date; format: yyyy-mm-dd	unitless
time_starttow	Time at start of tow (UTC); format: HH:MM	unitless
time_endtow	Time at end of tow (UTC); format: HH:MM	unitless
size_fraction	Sample size fraction. Tow material was sieved into the following size fractions: <150, 150-250, 250-500, 500-1000, 1000-2000, 2000-5000 and >5000 um.	micrometers (um)
notes	Indicates if a particular organism was measured (e.g., copepod) or not (in which case the sample is labelled 'bulk')	unitless
latitude	Latitude; positive values = North	decimal degrees
longitude	Longitude; positive values = East	decimal degrees
depth_tow	Depth of the tow	meters (m)
d15Nzoop_avg	Average d15N. d15N is the nitrogen isotopic composition of a sample expressed in delta notation (d15N in units of per mil, ‰) relative to atmospheric N2, where d15N = {[(15N/14N)sample/(15N/14N)atmN2] – 1} × 1000	per mil vs AIR
d15Nzoop_sd	Standard deviation of d15Nzoop_avg	per mil vs AIR
d15Nzoop_n	Number of replicate measurements of d15Nzoop_avg	unitless
ISO_DateTime_UTC_starttow	Date and time (UTC) of start of tow formatted to ISO 8601 standard; format: yyyy-mm-ddTHH:MM:SSZ	unitless
ISO_DateTime_UTC_endtow	Date and time (UTC) of end of tow formatted to ISO 8601 standard; format: yyyy-mm-ddTHH:MM:SSZ	unitless

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Instruments

Dataset-specific Instrument Name	Thermo Scientific FLASH 2000 elemental analyzer
Generic Instrument Name	Elemental Analyzer
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Dataset-specific Instrument Name	Thermo Scientific Delta V Plus
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	Thermo Scientific Delta V Plus
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	200-um-mesh plankton net
Generic Instrument Name	Plankton Net
Generic Instrument Description	A Plankton Net is a generic term for a sampling net that is used to collect plankton. It is used only when detailed instrument documentation is not available.

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Deployments

VOY016

Website	https://www.bco-dmo.org/deployment/805402
Platform	R/V S.A. Agulhas II
Start Date	2015-07-22
End Date	2015-08-15
Description	VOY016: Winter Cruise 2015, Good Hope Line. Subantarctic Atlantic, between South Africa and Antarctic winter sea-ice edge (at 56.4°S, 0.3°E).

VOY019

Website	https://www.bco-dmo.org/deployment/805403
Platform	R/V S.A. Agulhas II
Start Date	2016-04-07
Description	VOY019: Marion Cruise 2016. Subantarctic Indian, between South Africa and Marion/Prince Edward Islands (at 46.9°S, 37.7°E).

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Project Information

High-resolution, Assemblage-specific Records of Diatom-bound N Isotopes from the Indian Sector of the Antarctic Ocean (Diatom-bound_N_Isotopes)

Coverage: Kerguelen Plateau

Description from NSF award abstract:
The high concentration of the major nutrients nitrate and phosphate is a fundamental characteristic of the Antarctic Zone in the Southern Ocean and is central to its role in global ocean fertility and the global carbon cycle. The isotopic composition of diatom-bound organic nitrogen is one of the best hopes for reconstructing the nutrient status of polar surface waters over glacial cycles, which in turn may hold the explanation for the decline in atmospheric carbon dioxide during ice ages. The PIs propose to generate detailed diatom-bound nitrogen isotope (δ15Ndb) records from high sedimentation rate cores from the Kerguelen Plateau. Because the cores were collected at relatively shallow seafloor depths, they have adequate planktonic and benthic foraminifera to develop accurate age models. The resulting data could be compared with climate records from Antarctic ice cores and other archives to investigate climate-related changes, including the major steps into and out of ice ages and the millennial-scale events that occur during ice ages and at their ends. The records generated in this project will provide a critical test of hypotheses for the cause of lower ice age CO2.

This study will contribute to the goal of understanding ice ages and past CO2 changes, which both have broad implications for future climate. Undergraduates will undertake summer internships, with the possibility of extending their work into junior year projects and senior theses. In addition, the PI will lead modules for two Princeton programs for middle school teachers and will host a teacher for a six-week summer research project.

Understanding the nitrogen isotopes of planktonic foraminifera: A modern Sargasso Sea study (N Isotopes Foraminifera)

Coverage: Sargasso Sea

NSF Award Abstract:
Nitrogen (N) and phosphorus are the two nutrients required in large quantity by phytoplankton in the ocean, and together they limit productivity throughout most of the tropical, subtropical, and temperate ocean. Both the cycling of N and its input/output budget have been argued to control the fertility of the ocean and the ocean's role in setting atmospheric CO2. The CaCO3 tests of foraminifera can represent a substantial fraction of marine sediments and have been used extensively in paleoceanography; they are an obvious target for isotopic analysis of microfossil-bound organic matter.

In recent years, researchers at Princeton have developed a protocol for the isotopic analysis of foraminiferal shell-bound N. The current protocol is at least 100 times more sensitive than typical on-line combustion, allowing for rapid progress with a N isotope archive that was previously not feasible to measure. Measurements on surface sediments and a downcore record from the Caribbean show the promise of foraminifera-bound del15N (fb-del15N) to provide both a robust N isotope archive for paleoceanography, and

one with a unique potential of richness, given the existence of multiple foraminiferal species with different depth habitats and behaviors. Moreover, the finding from the Caribbean Sea record -- reduced N fixation in ice age Atlantic -- has changed the scientific conversation about the nature of the input/output budget of oceanic fixed N and its potential to change ocean fertility and atmospheric CO2. However, the controls on fb-del15N have not yet been adequately studied.

In this project, as a first major step in developing a foundation for the paleoceanographic application of fb-del15N, the same Princeton University team will study its genesis in the water column, transport to the seafloor, and early diagenesis. They will undertake this study in the Sargasso Sea south of Bermuda. This is one of the best studied regions of the ocean, in general and with respect to foraminifera, and a region that has been has been a focus of the N isotope research of the PI for the last decade and others previously. Moreover, its significant seasonality -- in physical oceanography, biogeochemistry, and foraminiferal species abundance -- will facilitate the effort to understand the controls on fb-del15N at a mechanistic level. The research team will participate in six Bermuda Atlantic Time-series Study (BATS) cruises over two years, collecting foraminifera and other N forms likely to provide insight into the controls on fb-del15N. From the nearby Oceanic Flux Program (OFP) moored sediment traps and from shallow sediments collected in the region, they will pick foraminifera shells and again make relevant ancillary measurements. This work will establish the relationship of foraminiferal biomass to shell-bound del15N for different species, and comparison of the foraminiferal isotope data with the upper ocean N pools will yield empirical isotopic relationships and work toward a mechanistic insight of fb-del15N (e.g., the importance of different N pools to the diets of different foraminifera; the role of algal symbionts). The sediment trap and surface sediment data will support the plankton tow data by integrating over longer time scales and will also address questions regarding late stage (e.g., gametogenic) calcification and the early diagenesis of fb-del15N and fb-N content.

Broader Impacts: This study will yield an improved understanding of the nutrient dynamics of foraminifera, a class of organisms whose shells are a central tool in micropaleontology and paleoclimatology. The project will also build on the principal investigator's involvement in the Bermuda Institute of Ocean Sciences as an asset for integrating ocean-related education and research at both the undergraduate and graduate levels.

MRI: Acquisition of Stable Isotope Instrumentation for the Biogeosciences at Princeton University (stable isotope instrumentation)

NSF Award Abstract:

Intellectual Merit:
The PIs are requesting funds to acquire a suite of instruments for stable isotope (N) research, including a denitrifier-based, natural abundance isotope system, a tracer isotope system, and general purpose natural abundance peripherals for an existing mass spectrometer. Specific instruments requested include a Thermo Electron MAT 253 stable isotope mass spectrometer, a Thermo DeltaVAdvantage stable isotope mass spectrometer with peripherals, an EA peripheral for combustion-based isotope analysis, and a GasBench II carbon dioxide preparation and purification system. The proposed instrumentation would enable research efforts examining natural stable isotope abundances that include ocean biogeochemistry and paleoceanography, terrestrial biogeochemistry, carbon isotopes in Precambrian Earth history. Stable isotope tracer research would include nitrification, nitrogen fixation, and carbon partitioning during biostimulation.

Broader Impacts:
The PIs state that the proposed instrumentation would expand the research capabilities of the institution and specifically the Departments of Geosciences and Ecology and Evolutionary Biology. The improvements to the denitrifier method will also serve to expand the capabilities of the ocean research community at large. Additionally, the proposed instrumentation will enable method development and provide training for undergraduate students at the institution and those participating in a collaborative effort with the University of Cape Town.

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Funding

Funding Source	Award
NSF Division of Polar Programs (NSF PLR)	PLR-1401489
NSF Division of Ocean Sciences (NSF OCE)	OCE-1060947
NSF Division of Ocean Sciences (NSF OCE)	OCE-0922345

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