Planktic foraminifer shell d15N from Oceanic Flux Program (OFP) sediment traps in the Sargasso Sea

Website: https://www.bco-dmo.org/dataset/747341
Data Type: Cruise Results
Version: 1
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Project
» Understanding the nitrogen isotopes of planktonic foraminifera: A modern Sargasso Sea study (N Isotopes Foraminifera)

Contributors	Affiliation	Role
Sigman, Daniel	Princeton University	Principal Investigator
Smart, Sandi M.	Stellenbosch University	Contact
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Planktic foraminifer shell d15N from sediment traps in the Sargasso Sea (off Bermuda) in the western subtropical North Atlantic. Sediment traps from 500 m, 1500 m, and 3200 m water depth (31°50'N, 64°10'W).

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Coverage

Spatial Extent: **Lat**:31.833 **Lon**:-64.167
Temporal Extent: 2009-11-23 - 2010-10-26

Dataset Description

Planktic foraminifer shell d15N from sediment traps in the Sargasso Sea (off Bermuda) in the western subtropical North Atlantic. Sediment traps from 500 m, 1500 m, and 3200 m water depth (31°50'N, 64°10'W).

Data published in:
Smart, S.M., H. Ren, S.E. Fawcett, R. Schiebel, M. Conte, P.A. Rafter, K.K. Ellis, M.A. Weigand, S. Oleynik, G.H. Haug, D.M. Sigman (2018). Ground-truthing the planktic foraminifer-bound nitrogen isotope paleo-proxy in the Sargasso Sea, Geochimica et Cosmochimica Acta, doi: https://doi.org/10.1016/j.gca.2018.05.023

Acquisition Description

Planktic foraminifer shells were picked from Oceanic Flux Program (OFP) sediment traps at 500 m, 1500 m, and 3200 m water depth (Conte et al., 2001; Conte and Weber, 2014). After crushing and the appropriate cleaning steps (Ren et al., 2012; Ren et al., 2015), shell-bound N was released by dissolution with hydrochloric acid, and organic N converted to nitrate using a basic persulfate oxidising reagent (POR; a potassium persulfate/sodium hydroxide solution) (Nydahl, 1978; Knapp et al., 2005). The "denitrifier method" was used to convert sample nitrate to N_2O gas for isotope analysis (Sigman et al., 2001; Casciotti et al., 2002; Weigand et al., 2016). See methods section of Smart et al. (2018) for more details of sample collection, isotope analysis and data quality.

The isotopic composition of N_2O was measured at Princeton University by GC-IRMS using a Thermo MAT 253 mass spectrometer with a purpose-built on-line N_2O extraction and purification system. See methods section of Smart et al. (2018) for more details of sample collection, isotope analysis and data quality.

Processing Description

Data Processing: Isotope ratio measurements were referenced against automated injections of N_2O from a gas cylinder, and then calibrated to N_2 in air using two international reference

materials IAEA-N3 and USGS-34 that were included in every run. An in-house N_2O standard was also measured along with each batch of samples to monitor mass spectrometry. Oxidized samples were additionally corrected for the contribution of the N blank associated with the POR.

Missing data identifier = -999

BCO-DMO Processing:
- modified parameter names (replaced spaces w/ underscores);
- formatted date from mm/dd/yyyy to yyyymmdd.

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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

Conte, M. H., Ralph, N., & Ross, E. H. (2001). Seasonal and interannual variability in deep ocean particle fluxes at the Oceanic Flux Program (OFP)/Bermuda Atlantic Time Series (BATS) site in the western Sargasso Sea near Bermuda. Deep Sea Research Part II: Topical Studies in Oceanography, 48(8-9), 1471–1505. doi:10.1016/S0967-0645(00)00150-8

Conte, M., & Weber, J. (2014). Particle Flux in the Deep Sargasso Sea: The 35-Year Oceanic Flux Program Time Series. Oceanography, 27(1), 142–147. doi:10.5670/oceanog.2014.17

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

Nydahl, F. (1978). On the peroxodisulphate oxidation of total nitrogen in waters to nitrate. Water Research, 12(12), 1123–1130. doi:10.1016/0043-1354(78)90060-X

Ren, H., Sigman, D. M., Thunell, R. C., & Prokopenko, M. G. (2012). Nitrogen isotopic composition of planktonic foraminifera from the modern ocean and recent sediments. Limnology and Oceanography, 57(4), 1011–1024. doi:10.4319/lo.2012.57.4.1011

Ren, H., Studer, A. S., Serno, S., Sigman, D. M., Winckler, G., Anderson, R. F., … Haug, G. H. (2015). Glacial-to-interglacial changes in nitrate supply and consumption in the subarctic North Pacific from microfossil-bound N isotopes at two trophic levels. Paleoceanography, 30(9), 1217–1232. doi:10.1002/2014PA002765

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

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

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

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Parameters

Parameter	Description	Units
species	Name of species	unitless
date	Date of sample collection (format: yyyymmdd)	unitless
num_individuals_500m	Number of individuals collected at 500 meters	unitless
num_individuals_1500m	Number of individuals collected at 1500 meters	unitless
num_individuals_3200m	Number of individuals collected at 3200 meters	unitless
num_individuals_TOTAL	Total number of individuals	unitless
d15N	d15N (per mil vs. AIR) 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
Total_N	Total Nitrogen	nanomoles (nmol)
weight	Weight of sample	milligrams (mg)
N_content	Nitrogen content	nanomoles per milligram (nmol/mg)

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Instruments

Dataset-specific Instrument Name	Thermo MAT 253
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	The isotopic composition of N2O was measured at Princeton University by GC-IRMS using a Thermo MAT 253 mass spectrometer with a purpose-built on-line N2O extraction and purification system.
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	mesh plankton net
Generic Instrument Name	Plankton Net
Dataset-specific Description	Living planktic foraminifera were collected for tissue N analysis from the upper 200 m of the water column using a 1-m2, 200-um-mesh plankton net aboard the R/V Atlantic Explorer during ten cruises between July 2011 and November 2013.
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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Project Information

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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0960802
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NSF Division of Ocean Sciences (NSF OCE)	OCE-1060947

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