Simulation of the volume-dependent changes in δ15N and δ18O for IAEA-NO3 and USGS-34 reference materials (Biological Nitrogen Isotope Fractionation project)

Website: https://www.bco-dmo.org/dataset/865685
Data Type: experimental
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Project
» CAREER: The biological nitrogen isotope systematics of ammonium consumption and production (Biological Nitrogen Isotope Fractionation)

Contributors	Affiliation	Role
Granger, Julie	University of Connecticut (UConn)	Principal Investigator
Zhou, Mengyang	University of Connecticut (UConn)	Student, Contact
Newman, Sawyer	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Simulation of the volume-dependent changes in δ15N and δ18O for IAEA-NO3 and USGS-34 reference materials.

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Methods & Sampling

Sampling and analytical procedures:

Effects of sample volume and salinity on O atom exchange with water

Given the potential influences on NO_3^- N and O isotope ratios, which include bacterial blanks, dissolved atmospheric N_2O, contaminant NO_3^- in reference materials, O atom exchange with water, and incomplete N_2O recovery and associated isotope fractionation, we attempt to reproduce the volume-dependent changes in $\delta^{15}N$ and $\delta^{18}O$ that we observed for IAEA-NO3 and USGS-34 reference materials.

The observed $ä^{15}N$ and $ä^{18}O$ values of N_2O for IAEA-NO3 and USGS-34 samples were referenced to that expected for IAEA-NO3 vs. the N_2O reference tank. The expected IAEA-NO3 has a $ä^{15}N$ of 0‰ vs. IAEA-NO3, and that expected for USGS-34 is -6.5‰ vs. IAEA-NO3. Being uncertain of the $ä^{18}O$ of the industrial N_2O in the reference tank, we approximate the expected $ä^{18}O$ value for IAEA-NO3 vs. N_2O_{ref} to be that observed for the highest N_2O yield (at lower aliquot volumes – which is admittedly already subject to blanks). Referenced to itself, the expected $ä^{18}O$ of IAEA-NO3 is 0‰ (vs. IAEA-NO3), and that for USGS-34 is -52.2‰ (vs. IAEA-NO3).

We compare the simulated $ä^{15}N$ and $ä^{18}O$ values to the observed average of 3 trials in dataset “Incidence of volume effect.”

Data Processing Description

Processing notes from researcher:

- Data were processed using Microsoft Excel

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Data Files

File
zhou_et_al_lab_data-9.csv (Comma Separated Values (.csv), 681 bytes) MD5:75b1940bbfdd6263a7bed5a054db51e1 Primary data file for dataset ID 865685

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Parameters

Parameter	Description	Units
Aliquot_volume	Sample volume injected to aliquot 10 nmol of nitrate	mL
Solution	Nitrate reference materials IAEA-NO3 and USGS-34	unitless
Observed_delta_15N_pcnt	Observed mean delta_15N of DIW and seawater samples in the 3 trials in Datasheet "Incidence of volume effect"	‰ vs. IAEA-NO3
stdev_of_observed_delta_15N	The standard deviation of trial means of delta_15N	unitlless
Expected_delta_15N_pcnt	IAEA-NO3 has a delta_15N of 0‰ vs. IAEA-NO3, and that expected for USGS-34 is -6.5‰ vs. IAEA-NO3.	‰ vs. IAEA-NO3
plus_blks_delta_15N_pcnt	delta_15N simulation accounting for a bacterial blank of 0.06 nmol N, atmospheric N2O of 0.013 nmol N mL-1, and nitrate contaminant in the solutions of 0.016 N nmol mL-1.	‰ vs. IAEA-NO3
plus_sparge_delta_15N_pcnt	delta_15N simulation accounting for blanks and the influence of incomplete sample sparging on the delta_15N values	‰ vs. IAEA-NO3
Observed_delta_18O_pcnt	Observed mean delta_18O of DIW and seawater sample in the 3 trials in Datasheet "Incidence of volume effect"	‰ vs. IAEA-NO3
stdev_of_observed_delta_18O_pcnt	The standard deviation of trial means of delta_18O	unitless
Expected_delta_18O_pcnt	IAEA-NO3 has a delta_18O of 0‰ vs. IAEA-NO3, and that expected for USGS-34 is -52.2‰ vs. IAEA-NO3.	‰ vs. IAEA-NO3
plus_blks_and_x_delta_18O_pcnt	_18O simulation accounting for a bacterial blank of 0.06 nmol N, atmospheric N2O of 0.013 nmol N mL-1, nitrate contaminant in the solutions of 0.016 N nmol mL-1, and O atom exchange fraction of 3%	‰ vs. IAEA-NO3
plus_sparge_delta_18O_pcnt	_18O simulation accounting for blanks, O atom exchange, and the influence of incomplete sample sparging on the _18O values	‰ vs. IAEA-NO3

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Project Information

CAREER: The biological nitrogen isotope systematics of ammonium consumption and production (Biological Nitrogen Isotope Fractionation)

NSF Award Abstract:
The nitrogen (N) cycle in the marine environment is controlled by biological processes. Unfortunately, quantifying these processes and assessing their effect on the N cycle is difficult by direct measurements because of large spatial and temporal differences. Isotopic composition measurements of N provide a means to constrain these processes indirectly; however, there is still a great deal to be understood about isotope fractionation of recycled nitrogen through biological processes, which has made interpretation of novel nitrogen isotope data difficult. A researcher from the University of Connecticut plans to determine the influence of biological consumption and production on the isotope fractionation in ammonium. By helping to understand the processes surrounding fractionation of recycled ammonium at the organism level, this research will create a basis for which future researchers can better interpret isotope composition data to infer nitrogen cycle dynamics. A graduate student, a postdoctoral fellow, and two or more undergraduate students will be involved in the research. The researcher plans to integrate science with community-engaged learning by developing an undergraduate field and laboratory course that will require the students to present their research to stakeholders in the community. There will be a manual created for this course that will be disseminated in open-access forums for teachers hoping to develop similar courses.

Biological nitrogen isotope fractionation associated with nitrogen recycling remains poorly constrained despite the advent of a variety of new techniques to analyze nitrogen isotopes in recent years. The use of isotopic composition data can be incredibly useful to interpreting nitrogen cycle processes in the ocean that are difficult to measure directly, which makes it crucial to further understand the processes behind fractionation to catch up with the advancement of the datasets available to researchers. This research will characterize the isotope fractionation dynamics of ammonium during biological consumption and production. The researchers will investigate whether the characteristic low concentrations of ammonium in the surface ocean affect isotope fractionation when the ammonium is recycled and whether there is a trophic isotope effect associated with ammonium recycling by protozoan grazers. With this research, there will be a baseline from which researchers can interpret recycled nitrogen dynamics from ammonium isotope datasets. The methods of comparing nitrogen cycling studies will become significantly clearer with such a standard making interpretation uniform by removing significant uncertainties.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1554474

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