Southern Ocean deep-sea fossil coral (Desmophyllum dianthus) nitrogen isotopes from R/V Nathaniel B. Palmer and R/V Thompson cruises between 2008 and 2011 (DeepSeaCoralNitrogen project)

Website: https://www.bco-dmo.org/dataset/683864
Data Type: experimental
Version:
Version Date: 2017-04-28

Project
» Nitrogen isotopic (d15N) composition of carbonate-bound organic nitrogen in Deep Sea Corals: A new, high resolution proxy for N cycle studies (DeepSeaCoralNitrogen)

Contributors	Affiliation	Role
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Dataset Description

This dataset contains d15N isotope data from fossil scleractinian coral (Desmophyllum dianthus) samples. Coral age from radiocarbon dating and Uranium-Thorium dating, sample depth, latitude, and longitude are also included. Deep-sea corals used in this study were collected from (1) sea-mounts south of Tasmania during cruise TN-228 in 2008–2009 on the R/V Thompson; and (2) the Drake Passage from May to June 2011 during cruise NBP1103 on the R/V Nathaniel B. Palmer.

These data were published in:

Wang, X. T., Sigman, D. M., Prokopenko, M. G., Adkins, J. F., Robinson, L. F., Hines, S. K., ... & Haug, G. H. (2017). Deep-sea coral evidence for lower Southern Ocean surface nitrate concentrations during the last ice age. Proceedings of the National Academy of Sciences, 201615718. doi: 10.1073/pnas.1615718114

Related dataset also from this publication:

d15N and age data from this dataset were used in the dataset:
Average coral nitrogen isotope records generated using Monte Carlo and Kalman Filters

Methods & Sampling

Nitrogen isotopes were generated using the persulfate oxidation and denitrified method in the Sigman Lab at Princeton University. The precision of this method is 0.2 permil (d15N vs. air)]. Samples were obtained from the collections of Jess F. Adkins (California Institute of Technology) and Laura F. Robinson (University of Bristol).

For more methodology details see Wang et al. 2017.

Wang, X. T., Sigman, D. M., Prokopenko, M. G., Adkins, J. F., Robinson, L. F., Hines, S. K., ... & Haug, G. H. (2017). Deep-sea coral evidence for lower Southern Ocean surface nitrate concentrations during the last ice age. Proceedings of the National Academy of Sciences, 201615718. doi: 10.1073/pnas.1615718114

Data Processing Description

These data are raw nitrogen isotope data generated in the Sigman Lab at Princeton University.

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Data Files

File
N_all_sites.csv (Comma Separated Values (.csv), 32.95 KB) MD5:6599e1a0ec6fa3ead48e7484bd5124eb Primary data file for dataset ID 683864

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	Gas chromatography
Generic Instrument Name	Gas Chromatograph
Generic Instrument Description	Instrument separating gases, volatile substances, or substances dissolved in a volatile solvent by transporting an inert gas through a column packed with a sorbent to a detector for assay. (from SeaDataNet, BODC)

Dataset-specific Instrument Name	isotope ratio mass spectrometry
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).

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Deployments

NBP1103

Website	https://www.bco-dmo.org/deployment/692813
Platform	RVIB Nathaniel B. Palmer
Start Date	2011-05-09
End Date	2011-06-11

NBP0805

Website	https://www.bco-dmo.org/deployment/694369
Platform	RVIB Nathaniel B. Palmer
Start Date	2008-04-19
End Date	2008-05-24

TN228

Website	https://www.bco-dmo.org/deployment/712357
Platform	R/V Thomas G. Thompson
Start Date	2008-12-16
End Date	2009-01-17

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Project Information

Nitrogen isotopic (d15N) composition of carbonate-bound organic nitrogen in Deep Sea Corals: A new, high resolution proxy for N cycle studies (DeepSeaCoralNitrogen)

Coverage: Sub-Antarctic waters and Antarctic waters

PI supplied project description:

Intellectual Merit

The history of the nitrogen (N) cycle provides insight into the links between past climate and marine biogeochemical cycles. Interpretations of the history of the N cycle rely on the nitrogen isotopic composition (del15N) of Particulate Organic Nitrogen (del15N-PON) preserved in sedimentary archives such as: bulk organic nitrogen (ON) buried in anoxic/suboxic sediments, skeletal-bound ON in diatom frustules and foraminiferal tests, and organic skeletons of deep-sea proteinaceous corals. As is often is the case with paleo-proxies, these archives have advantages, as well as limitations, the latter arising from temporal and/or spatial restrictions in distribution. Therefore, multiple archives are needed for better understanding the patterns and causes of N cycle variability in the past.

To improve upon the geographic and temporal resolution of del15N paleo-records, this projects evaluates a new proxy for the history of the marine N cycle-- del15N of ON bound within the mineral lattice of deep-sea corals (DSC). The project included two parts: 1) a modern calibration study; 2) a survey of d15N in the fossil corals from the Southern Ocean and comparison with previously published records of the diatom- and foraminifera-bound del15N.

Summary of findings

A survey of modern coral specimens (Desmophyllum dianthus) from disparate oceanographic environments, each chosen to represent a distinct del15N signature of PON exported from the euphotic zone showed strong statistical correlation between the coral-bound ON (CB-del15N) and del15N of regional export PON (Wang et al., 2014), establishing the fidelity of CB-del15N proxy.

In the second phase, the research group generated a set of time-resolved records of del15N in fossil D. dianthus from the Subantarctic (south of Tasmania and northern Drake Passage) and Antarctic (southern Drake Passage) regions of the Southern Ocean, spanning 40Ka through the present (Wang et al., 2017). In the modern Southern Ocean, the surface nutrients (including nitrate) are not fully consumed, resulting in leakage of deeply sequestered CO2 to the atmosphere. Incomplete nitrate consumption is manifested in low del15N of the exported modern PON. Wang et al. (2017) found that in both Southern Ocean regions the average CB-del15N during Last Glacial Maximum (LGM) was 4 to 5 permil higher than today. This finding provided a strong proof for the previously proposed hypothesis of the more efficient biological pump in the Southern Ocean, driving lower pCO2 during the ice ages. Stronger vertical stratification in the Antarctic and higher iron supply in the Subantarctic zones are the two likely reasons for the more efficient surface nitrate uptake during the LGM than occurs in the modern Southern Ocean.

The trends defined by the CB-del15N in the Southern Ocean corals were comparable to the previously published del15N records of diatom- and foraminifera-bound ON from both the Antarctic and Subantarctic zones, validating the reliability of the fossil deep-sea corals as paleo-archives. However, higher temporal resolution afforded by the DSC revealed a previously unnoticed feature: the CB-del15N in the Antarctic Zone continued to decrease through the Holocene, pointing to the ongoing decline in the nitrate uptake efficiency. One possible mechanism driving this change is the intensifying overturning of the Southern Ocean, which might have contributed to the rise in atmospheric pCO2 since 8 kyr.

For more information see the NSF award page

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1234664

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