

# Globorotaloides hexagonus trace element ablation profiles from samples collected from MOCNESS tows from R/V Sikuliaq cruise SKQ201701S in 2017

**Website:** <https://www.bco-dmo.org/dataset/919606>

**Data Type:** Cruise Results

**Version:** 1

**Version Date:** 2024-02-01

## Project

» [Glacial-Interglacial Changes in Oxygen Minimum Zones Using Deep-Dwelling, Low-Oxygen Planktic Foraminifera](#) (OMZ forams)

Contributors	Affiliation	Role
<a href="#">Davis, Catherine</a>	North Carolina State University (NCSU)	Principal Investigator
<a href="#">Doherty, Shannon</a>	North Carolina State University (NCSU)	Scientist
<a href="#">Fehrenbacher, Jennifer</a>	Oregon State University (OSU)	Scientist
<a href="#">Wishner, Karen</a>	University of Rhode Island (URI)	Scientist
<a href="#">York, Amber D.</a>	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

## Abstract

The planktic foraminifer *Globorotaloides hexagonus* is found in temperate to tropical oxygen minimum zones (OMZs). Their preferred habitat make *G. hexagonus* an important species for the development of oxygen-related paleoproxies. Here we report trace-element-to-calcium (TE/Ca) ratios with depth in the shell of *G. hexagonus* from the Eastern Tropical North Pacific (21°N, 117°W). Individuals were isolated from a series of Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS) tows on the R/V Sikuliaq in January and February 2017 and represent a wide range of depth habitats and oxygen concentrations. Oxygen concentration and depth from MOCNESS are provided in the metadata for each sample. Trace elements (Mg, Mn, Zn, Sr, Ba, Ca) were quantified using laser ablation ICP-MS from the outside to the inside of the shell, allowing for a reconstruction of TE/Ca with depth in the shell. MOCNESS data were collected by Dr. Karen Wishner (URI), ablation data were collected by Dr. Catherine Davis (NCSU) and Dr. Jennifer Fehrenbacher (OSU), and data were prepared by Dr. Shannon Doherty (NCSU and UAF).

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## Coverage

**Location:** Eastern Tropical North Pacific; 21.6°N, 117.8°W

**Spatial Extent:** N:21.86 E:-117.21 S:21.38 W:-117.8

**Temporal Extent:** 2017-01-09 - 2017-02-15

## Methods & Sampling

Detailed methodology for MOCNESS tows can be found in Wishner et al. (2018). Briefly, a 1 m<sup>2</sup> MOCNESS fitted with 222 micron nets was used to collect vertically stratified environmental data and plankton samples (9 nets per tow, 0-1000 m, 25-100 m intervals). Some tows also targeted oxygen minimum zone features. Nets were rinsed with filtered seawater and whole samples were preserved in 4% sodium-borate buffered formaldehyde.

Detailed methodology for sample preparation and analysis can be found in Davis et al. (2023). Foraminifera with intact cytoplasm were isolated from tow material to ensure samples were living at the time of collection. Shells of *G. hexagonus* were subjected to oxidative cleaning: shells were bathed individually in a 1:1 mixture of NaOH and H<sub>2</sub>O<sub>2</sub> for 10 minutes, then rinsed in deionized water. Shells were then mounted on carbon conductive tape on a glass slide. Trace element analysis was completed at the College of Earth, Ocean, and Atmospheric Sciences at Oregon State University using a laser ablation system (Photon Machines 193 nm ArF laser with an ANU HelEx dual-volume laser ablation cell, 65 mm spot size, a 4 Hz rep rate, and a fluence of 0.85 J cm<sup>-2</sup>) coupled to an iCAP quadrupole ICP-MS. Standards NIST 610 and NIST 612 were ablated every 10 samples.

## Data Processing Description

Ablation data were processed using LATools software (Branson et al. 2019).

## BCO-DMO Processing Description

\* Table "all\_ablations.csv" was imported into the BCO-DMO data system with values "NA" as missing data values.

\*\* Missing data values are displayed differently based on the file format you download. They are blank in csv files, "NaN" in MatLab files, etc.

\* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]

\* decimal places rounded from 18 to 8 places.

\* Columns added from dataset supplemental metadata table.

\* Columns added from supplemental table: date\_time\_UTC, Lat\_In, Lat\_Out

\* Columns added to this dataset by joining column "MOCNESS\_cast" and string "tow" "net" and "foram" with supplemental metadata table "MOCNESS\_cast" "net" and "foram".

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## Data Files

File
<b>919606_v1_g-hexagonus-laser-ablations.csv</b> (Comma Separated Values (.csv), 7.19 MB) MD5:65875390c1c4b4052e645d8165da03de
Primary data file for dataset ID 919606, version 1

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## Supplemental Files

## File

### Metadata

filename: G\_hexagonus\_ablation\_metadata.csv

(Comma Separated Values (.csv), 72.67 KB)  
MD5:2d1dae96c07561a4ba8aa860bb36bd0a

Metadata related to the MOCNESS tows and ablations.

Column information:

Column Name, Column Description, units

Column Name, Column Description [Include meaning of any codes or flags used in data column as well as detection limits.], Units of measurement  
MOCNESS\_cast, MOCNESS cast number from SKQ2017015, unitless

net, Net number for MOCNESS cast, unitless

foram, Number ID of individual foram for each net, unitless

ablation, Ablation number for each individual foram, unitless

chamber, Chamber ablated, unitless

net\_depth\_min, Minimum net depth, meters

net\_depth\_max, Maximum net depth, meters

net\_oxy\_conc\_max, Maximum net oxygen concentration, milliliters per liter

net\_oxy\_conc\_min, Minimum net oxygen concentration, milliliters per liter

net\_oxy\_conc\_mean, Mean net oxygen concentration, milliliters per liter

date\_time\_UTC, Collection date and UTC time in format yyyy-mm-ddThh:mm, unitless

Lat\_in, Latitude at time of MOCNESS recovery, degrees

Lat\_out, Latitude at time of MOCNESS deployment, degrees

Lon\_in, Longitude at time of MOCNESS recovery, degrees

Lon\_out, Longitude at time of MOCNESS deployment, degrees

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## Related Publications

Branson, O., Fehrenbacher, J. S., Vetter, L., Sadekov, A. Y., Eggins, S. M., & Spero, H. J. (2019). LAtools: A data analysis package for the reproducible reduction of LA-ICPMS data. *Chemical Geology*, 504, 83–95.

<https://doi.org/10.1016/j.chemgeo.2018.10.029>

*Software*

Davis, C. V., Doherty, S., Fehrenbacher, J., & Wishner, K. (2023). Trace element composition of modern planktic foraminifera from an oxygen minimum zone: Potential proxies for an enigmatic environment. *Frontiers in Marine Science*, 10. <https://doi.org/10.3389/fmars.2023.1145756>

*Results*

Davis, C. V., Wishner, K., Renema, W., & Hull, P. M. (2021). Vertical distribution of planktic foraminifera through an oxygen minimum zone: how assemblages and test morphology reflect oxygen concentrations.

*Biogeosciences*, 18(3), 977–992. doi:[10.5194/bg-18-977-2021](https://doi.org/10.5194/bg-18-977-2021)

*Results*

Wishner, K. F., Seibel, B. A., Roman, C., Deutsch, C., Outram, D., Shaw, C. T., ... Riley, S. (2018). Ocean deoxygenation and zooplankton: Very small oxygen differences matter. *Science Advances*, 4(12), eaau5180.

doi:[10.1126/sciadv.aau5180](https://doi.org/10.1126/sciadv.aau5180)

*Results*

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## Parameters

Parameter	Description	Units
filename	ID for each ablation in format MOCNESScast_net_foram_ablation from metadata	unitless
MOCNESS_cast	MOCNESS cast number from SKQ201701S	unitless
net	Net number for MOCNESS cast	unitless
foram	Number ID of individual foram for each net	unitless
file	file id	unitless
time	Time since start of ablation	seconds
X24Mg_43Ca	24Mg to 43Ca ratio (mol per mol)	mol per mol
X25Mg_43Ca	25Mg to 43Ca ratio (mol per mol)	mol per mol
X55Mn_43Ca	55Mn to 43Ca ratio (mol per mol)	mol per mol
X66Zn_43Ca	66Zn to 43Ca ratio (mol per mol)	mol per mol
X88Sr_43Ca	88Sr to 43Ca ratio (mol per mol)	mol per mol
X138Ba_43Ca	138Ba to 43Ca ratio (mol per mol)	mol per mol
depth	Depth in test	micron
date_time.UTC	Collection date and UTC time in format yyyy-mm-ddThh:mm	unitless
Lat_in	Latitude at time of MOCNESS recovery	decimal degrees
Lat_out	Latitude at time of MOCNESS deployment	decimal degrees

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## Instruments

<b>Dataset-specific Instrument Name</b>	
<b>Generic Instrument Name</b>	Inductively Coupled Plasma Mass Spectrometer
<b>Dataset-specific Description</b>	Photon Machines 193 nm ArF laser with an ANU HelEx dual-volume laser ablation cell iCAP quadrupole ICP-MS
<b>Generic Instrument Description</b>	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

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## Deployments

### SKQ201701S

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/755461">https://www.bco-dmo.org/deployment/755461</a>
<b>Platform</b>	R/V Sikuliaq
<b>Start Date</b>	2017-01-19
<b>End Date</b>	2017-02-15
<b>Description</b>	See additional cruise information from R2R: <a href="https://www.rvdata.us/search/cruise/SKQ201701S">https://www.rvdata.us/search/cruise/SKQ201701S</a>

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## Project Information

### Glacial-Interglacial Changes in Oxygen Minimum Zones Using Deep-Dwelling, Low-Oxygen Planktic Foraminifera (OMZ forams)

**Coverage:** eastern Pacific

NSF abstract:

Oxygen minimum zones (OMZs) are naturally occurring regions of low oxygen found across large swaths of the ocean at depths of 100 to 1000 meters below the surface. OMZs play an important role in biogeochemical cycling and ecosystem function and any change in the expanse of their low oxygen waters can have far reaching implications for marine life and valuable fisheries resources. Marine oxygenation is variable on multiple timescales in response to global climate change, with recent observations showing that OMZs have expanded over the past half century. This project will explore promising new geochemical and morphologic proxies applicable to low-oxygen environments in the planktic foraminifer *Globorotaloides hexagonus*, a unicellular calcifying organism whose fossil record in seafloor sediments is well suited to reconstructing past low-oxygen environments in the water column. The project will focus on the extensive OMZ of the eastern tropical Pacific. The first goal is to evaluate and calibrate the targeted measurements for modern *G. hexagonus* collected live in plankton tows. The second goal is to apply these proxies to fossil specimens in sediment cores to generate records of glacial-Holocene change. The outcomes will be useable proxies for generating records of the OMZ environment, and a better understanding of how a major regional OMZ changed during the most recent period of rapid climate change. Both outcomes represent important progress towards understanding natural oscillations in the OMZ as well as modeling and planning for a changing OMZ in the face of global climate perturbations. The project will provide opportunities for undergraduate researchers as well as support a female early career researcher.

The marine sedimentary record is the most promising archive from which to reconstruct long term marine oxygenation. However, significant limitations exist in the available proxies for low oxygen marine environments. This project aims to address this need by evaluating and applying a range of promising geochemical (trace element and stable isotope) and morphologic (area-density and porosity) proxies relevant to low oxygen environments in the planktic foraminifer *Globorotaloides hexagonus*. The project will develop viable proxies based on the morphology and geochemistry of *G. hexagonus* shells previously collected in depth-distributed MOCNESS (Multiple Opening/Closing Net and Environmental Sensing System) tows from the eastern Pacific. The results from this proxy development in modern shells will then be ground-truthed and applied to two already well characterized sediment cores from the Mexican Margin and Panama Basin that span from the Last Glacial Maximum through the Holocene. The sediment records will be used to reconstruct past conditions in the eastern tropical Pacific OMZ, where significant questions about glacial-interglacial oxygenation persist. This research will lead to a more mechanistic understanding of how OMZs respond to climate more broadly.

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## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1851589</a>

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