RR2311 bottle data from R/V Roger Revelle cruise RR2311 in the Eastern Tropical South Pacific from November to December 2023

Website: https://www.bco-dmo.org/dataset/924943
Data Type: Cruise Results
Version: 1
Version Date: 2024-04-15

Project
» Nitrite Oxidation in Oxygen Minimum Zones (NO2Ox_OMZs)

Contributors	Affiliation	Role
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Abstract
This dataset includes the Niskin bottle data collected on R/V Roger Revelle cruise RR2311 in the Eastern Tropical South Pacific, off the coast of Chile and Peru, from November to December 2023. Data were processed with Seasave V 7.26.7.121.

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Coverage

Location: Eastern Tropical South Pacific, off the coast of Chile and Peru
Spatial Extent: **N**:-13.9998 **E**:-71.0994 **S**:-22.9006 **W**:-81.0005
Temporal Extent: 2023-11-21 - 2023-12-18

Methods & Sampling

These data were collected on R/V Roger Revelle cruise RR2311 in the Eastern Tropical South Pacific, off the coast of Chile and Peru, during November and December 2023. The cruise track included five process stations, three of which were designated oxygen-deficient zone (ODZ) stations (contained a relatively thick interval of oxygen-depleted water, PS1, PS2, PS3) and two of which were outside the strong oxygen minimum zone (PS4, PS5). Experimental manipulations to measure nitrogen (N) cycle processes were carried out at these stations. The sampling strategy was tailored to the process under investigation, e.g., photosynthesis in surface waters, denitrification in oxygen depleted layers. Complete depth profiles were measured for a few processes (nitrification) but most experiments targeted a few critical features (e.g., oxycline, core of the ODZ).

Nine transect stations were included at approximately evenly spaced intervals between the process stations and the end point of the cruise in Arica, Chile. Depth profiles of dissolved inorganic nitrogen nutrients and nitrous oxide were measured at the transect stations.

Data Processing Description

CTD data were processed with Seasave V 7.26.7.121.

BCO-DMO Processing Description

- Imported original file "RR2311_all_bottle_data.xlsx" into the BCO-DMO system.
- Created the ISO_DateTime_UTC column using the Month, Day, Year, and Time columns as input.
- Saved the final file as "924943_v1_rr2311_bottle.csv".

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Data Files

File
924943_v1_rr2311_bottle.csv (Comma Separated Values (.csv), 164.28 KB) MD5:7e923e0c1b94508c1a65b19dd8578f0f Primary data file for dataset ID 924943, version 1

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Parameters

Parameter	Description	Units
Cast	CTD cast number	unitless
Bottle	Niskin bottle number	unitless
ISO_DateTime_UTC	Date and time (UTC) of the cast/event in ISO 8601 format	unitless
Month	calendar month abbreviation	unitless
Day	day of the month	unitless
Year	year	unitless
Time	Time UTC of the cast/event (source: Ship)	unitless
Latitude	Latitude, N is positive (source: Ship)	decimal degrees
Longitude	Longitude, E is positive (source: Ship)	decimal degrees
Depth	depth (source: CTD)	meters (m)
SigmaTheta	sigma theta (source: CTD)	kilograms per cubic meter (kg/m3)
Salinity	salinity (source: CTD)	PSU
Temperature	temperature (source: CTD)	degrees Celsius
ChlFlour	fluorescence (source: CTD)	milligrams per cubic meter (mg/m3)
Oxygen	SBE O2 sensor (source: CTD)	micromoles per liter (umol/l)

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Instruments

Dataset-specific Instrument Name	Sea-Bird 9
Generic Instrument Name	CTD Sea-Bird 9
Generic Instrument Description	The Sea-Bird SBE 9 is a type of CTD instrument package. The SBE 9 is the Underwater Unit and is most often combined with the SBE 11 Deck Unit (for real-time readout using conductive wire) when deployed from a research vessel. The combination of the SBE 9 and SBE 11 is called a SBE 911. The SBE 9 uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 and SBE 4). The SBE 9 CTD can be configured with auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorometer, altimeter, etc.). Note that in most cases, it is more accurate to specify SBE 911 than SBE 9 since it is likely a SBE 11 deck unit was used. more information from Sea-Bird Electronics

Dataset-specific Instrument Name	
Generic Instrument Name	Niskin bottle
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

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Deployments

RR2311

Website	https://www.bco-dmo.org/deployment/924949
Platform	R/V Roger Revelle
Start Date	2023-11-18
End Date	2023-12-20
Description	See additional cruise information at R2R: https://www.rvdata.us/search/cruise/RR2311

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Project Information

Nitrite Oxidation in Oxygen Minimum Zones (NO2Ox_OMZs)

Coverage: Eastern Tropical South Pacific and Chesapeake Bay

NSF Award Abstract:
This research is grounded in the fundamental role of nitrogen in limiting production in the ocean. Nitrite is a pivotal compound in the nitrogen cycle: it can be oxidized to nitrate, and thus retained as an available nutrient,

or it can be reduced to dinitrogen gas, and thus lost from the bioavailable nitrogen pool. Oxidation of nitrite by nitrite oxidizing bacteria (NOB) is the only biological pathway by which nitrate is produced, and all known NOB require oxygen for life. The reduction pathway is also carried out by microbes, in this case, bacteria that thrive only in the absence of oxygen. In previous experiments, however, both oxidation and reduction of nitrite were detected in the same samples from ocean waters in the absence of oxygen. We will investigate three explanations for the apparent oxidation of nitrite in the absence of oxygen on a research cruise to the low oxygen waters off the coast of Peru: 1) The presence of unknown kinds of NOB that do not require oxygen; 2) a new reaction called dismutation, which is possible but never detected in nature; 3) an artifact associated with oxygen stress in NOB. This research could lead to discovery of novel mechanisms and or novel organisms that determine the fate of nitrite and the availability of nitrogen to support primary production in the long run. This project will advance discovery and understanding while promoting teaching, training and learning by providing opportunities for Princeton students to get involved in and have hands on experience in research in the lab and potentially at sea. Both undergraduate and graduate students will participate in the research through internships and field experiences. We will also integrate our work at sea into teaching in the classroom via videos and assignments based on data collected during the cruise.

Nitrite oxidation is the only known biological process that produces nitrate, which comprises the largest fixed nitrogen reservoir in the ocean. Nitrite oxidation is carried out by nitrite oxidizing bacteria (NOB), and all known species are obligate aerobes. Nitrite reduction to N2 occurs in multiple microbial pathways, generally under anoxic conditions. Despite their apparent incompatibility regarding oxygen, both processes are detected in the low oxygen or anoxic waters of oxygen minimum zones (OMZs). Thus, the fate of nitrite in OMZs has implications for the global fixed N budget. Nitrite oxidation is detected at high rates in essentially zero oxygen water in the most oxygen depleted depth intervals in OMZ regions, which suggests that some nitrite oxidizers might possess anaerobic metabolic capabilities. Nitrite disproportionation (or dismutation), in which nitrite is simultaneously oxidized to nitrate and reduced to N2, is a thermodynamically favorable reaction, which would link the two processes in one organism – but it has never been observed in nature. The research proposed here will address two big questions about nitrite in the ocean: 1) How does anaerobic nitrite oxidation work? 2) What determines the fate of nitrite? The experimental approach will investigate three possible explanations for anaerobic nitrite oxidation: 1) Nitrite is oxidized to nitrate by different clades of NOB, which exhibit different tolerances/requirements for oxygen; 2) Nitrite dismutation, also performed by NOB, partially explains the cooccurrence of oxidation and reduction of nitrite; 3) Apparently anaerobic nitrite oxidation is indeed biologically mediated but does not always represent net production of nitrate from nitrite; rather it results from isotopic equilibration during enzyme-catalyzed interconversion of nitrite and nitrate. These questions will be addressed by performing a suite of 15N-tracer incubations at stations located within and outside of one of the major OMZs in the ocean, the Eastern Tropical South Pacific. The dependence of the rate processes on oxygen concentrations will be determined, and the composition of the microbial assemblages will be assessed in order to determine whether different microbial components are involved under different environmental conditions. The expression of genes involved in oxidation/reduction/ respiratory metabolisms at low oxygen concentrations will be measured across oxygen gradients and in oxygen manipulations to identify their potential role in supporting “anaerobic” nitrite oxidation. The possibility that the apparently anaerobic nitrite oxidation is due to an enzyme level interconversion between nitrite and nitrate, which does not lead to net nitrate production and is not linked to growth of nitrite oxidizing bacteria, will also be investigated.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1946516

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