McLane pumps log deployed on the R/V Atlantis CliOMZ AT50-10 expedition from Golfito Costa Rica to San Diego USA that occurred in May - June of 2023.

Website: https://www.bco-dmo.org/dataset/921847
Data Type: Cruise Results
Version: 1
Version Date: 2024-04-30

Project
» Collaborative Research: Underexplored Connections between Nitrogen and Trace Metal Cycling in Oxygen Minimum Zones Mediated by Metalloenzyme Inventories (CliOMZ)

Contributors	Affiliation	Role
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Abstract
This is the log for the McLane pumps deployed on the R/V Atlantis CliOMZ AT50-10 expedition from Golfito Costa Rica to San Diego USA that occurred in May - June of 2023. The log contains metadata associated with each pump deployment, including location, pump depth, and time. The pumps were launched on 1/4" kevlar line spooled on a MASH2K winch from the East Coast Winch Pool. The Science party included members from WHOI, UCSB, UTGRV, and Clark University.

Table of Contents

Coverage

Spatial Extent: **N**:25.0802 **E**:-88.9709 **S**:-10.0244 **W**:-118.098
Temporal Extent: 2023-05-04 - 2023-06-06

Methods & Sampling

Seven Large Volume Water Transfer Systems (McLane pumps) were deployed during research cruise AT50-10 attached to a synthetic wire using a MASH2K winch and a dual filter sampler system. Deployments lasted 3 or 4 hours and seawater was filtered at specific depths. A combination of 0.2 um Supor membranes and 51 um pore size Nitex mesh was used for one side while the other side pump water through a Glass Fiber Filter (GFF). See data log for specific size fraction combination as well as specific samples taken.

Data Processing Description

The depths for McLane pumps (which lack pressure sensors) were calculated based on winch payout and a calibration curve generated aboard ship. The need for calibration arises from the MASH2K winch not being used with metallic wire for this application. By using (non-conducting) synthetic wire for trace metal clean needs, the wire wraps are not predictably uniform as with metallic wire. As a result and the MASH2K instrument borrowed from the East Coast Winch Pool was not programmed for depths using synthetic wire. To compensate for this the McLane pump payout calibration was estimated using the Trace Metal rosette deployed with a SSSG Pinger, with depth from the ship and the winch payout recorded at 17 intervals between 0 and 4287 meters. A power law relationship was calculated from this relationship by Tristan Horner where: True Payout = Raw Payout / (1.34 x Raw Payout^-0.026). This equation had a mean absolute standard deviation of 5m for the 17 depths recorded, with depth variance increasing with depth. This equation was applied to the payout readings from the winch when used for McLane pumps to calculate the deployment Depth (m) parameter.

Problem Description

Cast # 20 was programmed to the incorrect starting time due to a change of time zone from -6 to -7 GMT and therefore pumped in the wrong depth for one hour.

Two McLane pump deployments were not added to the ELOG before the end of the cruise (Cast 20 and Cast 21), therefore, coordinates for those two activities were determined based on the corresponding Clio deployment at the same station (CLIO049 and CLIO050 respectively).

[table of contents | back to top]

Data Files

File
921847_v1_mclanepumps.csv (Comma Separated Values (.csv), 43.37 KB) MD5:62f33afd43ecb4db31e2ced424535a16 Primary data file for dataset ID 921847, version 1

[table of contents | back to top]

Parameters

Parameter	Description	Units
Cruise_ID	Cruise ID AT50-10	unitless
Start_date_UTC	Pump start date	unitless
Start_time_UTC	Pump start time	unitless
End_date_UTC	Pump end date	unitless
End_time_UTC	Pump end time	unitless
Station_number	Station number	unitless
Start_Lat	Pump start latitude	decimal degrees
Start_Long	Pump start longitude	decimal degrees
End_Lat	Pump end latitude	decimal degrees
End_Long	Pump end longitude	decimal degrees

Cast_number	Cast number	unitless
Pump_number	Pump number	unitless
Head_number_GFF_port	Pump head identification number at GFF water port in dual samlpler system	unitless
Head_number_Supor_port	Pump head identification number at Supor/Nitex water port in dual samlpler system	unitless
Winch_payout_reading	Winch payout reading	meters (m)
Corrected_winch_payout	Correct winch payout	meters (m)
Depth	Sample depth	meters (m)
Total_time_filtered	Total time filtered	minutes (min)
GFF_side_flow_meter_volume	Volume of water filtered through the GFF side in dual sampler system	liters (L)
Supor_side_flow_meter_volume	Volume of water filtered through the Supor side in dual sampler system	liters (L)
Filter_diameter	Filter diameter	millimeters (mm)
Comments_deployment	Comments on deployment	unitless
SAMPLE_PRFEIX	Sample prefix	unitless
SUPOR_0_2_FRACTION_PROTEIN1	Fraction of 142mm diameter 0.2um pore size Supor (PES) filter assigned for global metaproteomic analysis	unitless
SUPOR_0_2_FRACTION_DNA1	Fraction of 142mm diameter 0.2um pore size Supor (PES) filter assigned for genomic DNA analysis, sample 1 of 2	unitless
SUPOR_0_2_FRACTION_DNA2	Fraction of 142mm diameter 0.2um pore size Supor (PES) filter assigned for genomic DNA analysis, sample 2 of 2	unitless
SUPOR_0_2 FRACTION_eDNA	Fraction of 142mm diameter 0.2um pore size Supor (PES) filter assigned for environmental DNA analysis	unitless
SUPOR_0_2_FRACTION_pMetal	Fraction of 142mm diameter 0.2um pore size Supor (PES) filter assigned for particulate metal content analysis	unitless
SUPOR_0_2 FRACTION_POS	Fraction of 142mm diameter 0.2um pore size Supor (PES) filter assigned for particulate organic sulfur analysis	unitless

SUPOR_0_2_FRACTION_metatranscriptomics_Intercomparison	Fraction of 142mm diameter 0.2um pore size Supor (PES) filter assigned for metatranscriptomic intercomparison analysis	unitless
SUPOR_0_2_FRACTION_metagenomics_Intercomparison	Fraction of 142mm diameter 0.2um pore size Supor (PES) filter assigned for metagenomic intercomparison analysis	unitless
NITEX_51_FRACTION_PROTEIN1	Fraction of 142mm diameter 51um pore size Nitex filter assigned for global metaproteomics	unitless
NITEX_51_FRACTION_DNA1	Fraction of 142mm diameter 51um pore size Nitex filter assigned for genomic DNA analysis	unitless
NITEX_51_FRACTION_pMetal	Fraction of 142mm diameter 51um pore size Nitex filter assigned for particulate metal content analysis	unitless
NITEX_51_FRACTION_CULTURING	Fraction of 142mm diameter 51um pore size Nitex filter assigned for bacteria culturing	unitless
GFF_FRACTION_PROTEIN1	Fraction of 142mm diameter 0.7um pore size Glass Fiber Filter (GFF) filter assigned for global metaproteomics	unitless
GFF_FRACTION_CA	Fraction of 142mm diameter 0.7um pore size Glass Fiber Filter (GFF) filter assigned for carbonic anhydrase activity analysis	unitless
GFF_FRACTION_PIGS	Fraction of 142mm diameter 0.7um pore size Glass Fiber Filter (GFF) filter assigned for photosynthetic pigments analysis	unitless
GFF_FRACTION_POC	Fraction of 142mm diameter 0.7um pore size Glass Fiber Filter (GFF) filter assigned for particulate organic carbon analysis	unitless
GFF_FRACTION_HG	Fraction of 142mm diameter 0.7um pore size Glass Fiber Filter (GFF) filter assigned for mercury content analysis	unitless
SAMPLE_COMMENT	Comments on sample taken	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Large Volume Water Transfer Systems (McLane pumps)
Generic Instrument Name	McLane Large Volume Pumping System WTS-LV
Dataset-specific Description	Seven Large Volume Water Transfer Systems (McLane pumps; McLane labs: https://mclanelabs.com/wts-lv-large-volume-pump/) were deployed during research cruise AT50-10 attached to a synthetic wire using a MASH2K winch and a dual filter sampler system. A combination of 0.2 um Supor membranes and 51 um pore size Nitex mesh was used for one side while the other side pump water through a Glass Fiber Filter (GFF).
Generic Instrument Description	The WTS-LV is a Water Transfer System (WTS) Large Volume (LV) pumping instrument designed and manufactured by McLane Research Labs (Falmouth, MA, USA). It is a large-volume, single-event sampler that collects suspended and dissolved particulate samples in situ. Ambient water is drawn through a modular filter holder onto a 142-millimeter (mm) membrane without passing through the pump. The standard two-tier filter holder provides prefiltering and size fractioning. Collection targets include chlorophyll maximum, particulate trace metals, and phytoplankton. It features different flow rates and filter porosity to support a range of specimen collection. Sampling can be programmed to start at a scheduled time or begin with a countdown delay. It also features a dynamic pump speed algorithm that adjusts flow to protect the sample as material accumulates on the filter. Several pump options range from 0.5 to 30 liters per minute, with a max volume of 2,500 to 36,000 liters depending on the pump and battery pack used. The standard model is depth rated to 5,500 meters, with a deeper 7,000-meter option available. The operating temperature is -4 to 35 degrees Celsius. The WTS-LV is available in four different configurations: Standard, Upright, Bore Hole, and Dual Filter Sampler. The high-capacity upright WTS-LV model provides three times the battery life of the standard model. The Bore-Hole WTS-LV is designed to fit through a narrow opening such as a 30-centimeter borehole. The dual filter WTS-LV features two vertical intake 142 mm filter holders to allow simultaneous filtering using two different porosities.

[table of contents | back to top]

Deployments

AT50-10

Website	https://www.bco-dmo.org/deployment/916122
Platform	R/V Atlantis
Report	https://www.rvdata.us/search/cruise/AT50-10
Start Date	2023-05-02
End Date	2023-06-09

[table of contents | back to top]

Project Information

Collaborative Research: Underexplored Connections between Nitrogen and Trace Metal Cycling in Oxygen Minimum Zones Mediated by Metalloenzyme Inventories (CliOMZ)

Coverage: Eastern Tropical Pacific

NSF abstract:

Though scarce and largely insoluble, trace metals are key components of sophisticated enzymes (protein molecules that speed up biochemical reactions) involved in biogeochemical cycles in the dark ocean (below 1000m). For example, metalloenzymes are involved in nearly every reaction in the nitrogen cycle. Yet, despite direct connections between trace metal and nitrogen cycles, the relationship between trace metal distributions and biological nitrogen cycling processes in the dark ocean have rarely been explored, likely due to the technical challenges associated with their study. Availability of the autonomous underwater vehicle (AUV) Clio, a sampling platform capable of collecting high-resolution vertical profile samples for biochemical and microbial measurements by large volume filtration of microbial particulate material, has overcome this challenge. Thus, this research project plans an interdisciplinary chemistry, biology, and engineering effort to test the hypothesis that certain chemical reactions, such as nitrite oxidation, could become limited by metal availability within the upper mesopelagic and that trace metal demands for nitrite-oxidizing bacteria may be increased under low oxygen conditions. Broader impacts of this study include the continued development and application of the Clio Biogeochemical AUV as a community resource by developing and testing its high-resolution and adaptive sampling capabilities. In addition, metaproteomic data will be deposited into the recently launched Ocean Protein Portal to allow oceanographers and the metals in biology community to examine the distribution of proteins and metalloenzymes in the ocean. Undergraduate students will be supported by this project at all three institutions, with an effort to recruit minority students. The proposed research will also be synergistic with the goals of early community-building efforts for a potential global scale microbial biogeochemistry program modeled after the success of the GEOTRACES program, provisionally called "Biogeoscapes: Ocean metabolism and nutrient cycles on a changing planet".

The proposed research project will test the following three hypotheses: (1) the microbial metalloenzyme distribution of the mesopelagic is spatially dynamic in response to environmental gradients in oxygen and trace metals, (2) nitrite oxidation in the Eastern Tropical Pacific Ocean can be limited by iron availability in the upper mesopelagic through an inability to complete biosynthesis of the microbial protein nitrite oxidoreductase, and (3) nitrite-oxidizing bacteria increase their metalloenzyme requirements at low oxygen, impacting the distribution of both dissolved and particulate metals within oxygen minimum zones. One of the challenges to characterizing the biogeochemistry of the mesopelagic ocean is an inability to effectively sample it. As a sampling platform, we will use the novel biogeochemical AUV Clio that enables high-resolution vertical profile samples for biochemical and microbial measurements by large volume filtration of microbial particulate material on a research expedition in the Eastern Tropical Pacific Ocean. Specific research activities will be orchestrated to test the hypotheses. Hypothesis 1 will be explored by comparison of hydrographic, microbial distributions, dissolved and particulate metal data, and metaproteomic results with profile samples collected by Clio. Hypothesis 2 will be tested by incubation experiments using 15NO2- oxidation rates on Clio-collected incubation samples. Hypothesis 3 will be tested by dividing targeted nitrite oxidoreductase protein copies by qPCR (quantitative polymerase chain reaction)-based nitrite oxidizing bacteria abundance (NOB) to determine if cellular copy number varies with oxygen distributions, and by metalloproteomic analyses of NOB cultures. The demonstration of trace metal limitation of remineralization processes, not just primary production, would transform our understanding of the role of metals in biogeochemical cycling and provide new ways with which to interpret sectional data of dissolved and particulate trace metal distributions in the ocean. The idea that oxygen may play a previously underappreciated role in controlling trace metals due not just to metals' physical chemistry, but also from changing biological demand, will improve our ability to predict trace metal distributions in the face of decreasing ocean oxygen content.

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1924554

[table of contents | back to top]