

Log file from AUV Clio taken on R/V Atlantis (CliOMZ AT50-10 expedition) from Golfito Costa Rica to San Diego USA in May-June 2023.

Website: <https://www.bco-dmo.org/dataset/929764>

Data Type: Cruise Results

Version: 1

Version Date: 2024-06-13

Project

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

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Abstract

This dataset contains the dive log from Autonomous Underwater Vehicle (AUV) Clio which was obtained during the CliOMZ AT50-10 expedition onboard R/V Atlantis from May-June 2023. The dataset contains metadata specifying sampling characteristics for each dive.

Table of Contents

- [Coverage](#)
- [Dataset Description](#)
 - [Methods & Sampling](#)
 - [BCO-DMO Processing Description](#)
 - [Problem Description](#)
- [Related Publications](#)
- [Related Datasets](#)
- [Parameters](#)
- [Instruments](#)
- [Deployments](#)
- [Project Information](#)
- [Funding](#)

Coverage

Spatial Extent: N:25.094033 E:-88.964731 S:-10.052473 W:-118.131032

Temporal Extent: 2023-05-04 - 2023-06-07

Methods & Sampling

Dive log for Clio dives 031-050. In depth operation summary for each dive can be found in the Clio Operations Report (see related publications).

BCO-DMO Processing Description

- * Removed headers that were diving up the dive plan file
- * Remove total volume calculation at bottom of dive plan file
- * Converted dates to ISO format
- * Converted lat/lon to decimal degrees
- * Removed empty fields from diveplan [DATE TIME RECOVERY] - redundant

Problem Description

- * Clio031: No data due to ballast issues
- * Clio032: BUSHBABY was inadvertently programmed with an incorrect port number for the last sample. The port number should have been 4. Optode failed to record data below 400 m
- * Clio033: Incubation chamber bags did not fill
- * Clio036: BUSHBABY started pumping too early on port 8 & 9
- * Clio041: Vehicle surface an hour early due to a missed sample at 140 m.

[[table of contents](#) | [back to top](#)]

Related Publications

Jakuba, M. V., & Dalpe, A. J. (2024). Clio Operations Report for the AT50-10 Saito Cruise. Woods Hole Oceanographic Institution. <https://doi.org/10.1575/1912/69648>
Results

[[table of contents](#) | [back to top](#)]

Related Datasets

IsRelatedTo

Saito, M. A., Dalpe, A., Jakuba, M., Breier, J., Moore, N. (2024) **Processed first profiles of sensor data from AUV Clio taken on R/V Atlantis (CliOMZ AT50-10 expedition) from Golfito Costa Rica to San Diego USA in May-June 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-05-24 <http://lod.bco-dmo.org/id/dataset/928684> [[view at BCO-DMO](#)]
Relationship Description: Processed first profiles of data for each dive.

Saito, M. A., Dalpe, A., Jakuba, M., Breier, J., Moore, N. (2024) **Raw Sensor files from AUV Clio taken on R/V Atlantis (CliOMZ AT50-10 expedition) from Golfito Costa Rica to San Diego USA in May-June 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-04-23 <http://lod.bco-dmo.org/id/dataset/925614> [[view at BCO-DMO](#)]
Relationship Description: Raw Sensor files from AUV Clio

Saito, M. A., Dalpe, A., Jakuba, M., Breier, J., Moore, N. (2024) **Summaries of tigerclaw and bushbaby tracers from AUV Clio taken on R/V Atlantis (CliOMZ AT50-10 expedition) from Golfito Costa Rica to San Diego USA in May-June 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-05-24 <http://lod.bco-dmo.org/id/dataset/928720> [[view at BCO-DMO](#)]
Relationship Description: Summaries of tigerclaw and bushbaby tracers mounted on the vehicle.

[[table of contents](#) | [back to top](#)]

Parameters

Parameter	Description	Units
CRUISE_ID	Cruise name	unitless
PROGRAM_ID	Program name	unitless
CLIO_DIVE_ID	Clio dive number, sequential	unitless

UID	Unique identifier of format dive#_SUPRsamplername_SUPRvalve# (TC = Tigerclaw; BB = Bushbaby)	unitless
STATION	Cruise station number	unitless
DEPTH_STATION_TYPE	Adaptive or non-adaptive sampling	unitless
DEPTH_STATION_ORDER	The order in which samples were collected	unitless
DEPTH_STATION_PARAMETERS	The depth at which the vehicle was commanded to sample. Note for adaptive samples, this was the initialized depth, but may have been changed with the adaptive behavior. See actual depth column.	meters
BAY	The payload bay number (1-4) on AUV Clio where the SUPR sampler that took the sample was installed	unitless
SUPR_UNIT	Which Supr unit took the sample (BUSHBABY or TIGERCLAW)	unitless
SUPR_VALVE	Which valve the sample was pumped on	unitless
SUPR_FILTER_INCUBATOR	The filter number as installed in the SUPR sampler	unitless
FILTERS	The type of filter installed	unitless
STOP_CONDITION_TIME_VOL_RATE	What triggers sampling to stop: time, volume, or rate	minutes (time), liters (volume), liters per minute (rate)
STOP_TIME	The duration at which the SUPR sampler is set to stop pumping (unit = minutes) when time is used as the stop criterion.	minutes
STOP_VOLUME	The volume at which the SUPR sampler is set to stop pumping (unit = liters) when volume is used as the stop criterion.	liters
STOP_RATE	The minimum flow rate below which the SUPR sampler is set to stop pumping (unit = liters per minute) when flow rate is used as the stop criterion.	liters per minute
INCUBATOR_PURGE_TIME	The duration set for the incubator to perform its purge sequence	minute
INCUBATOR_FILL_TIME	The duration set for the incubator to fill	minute
SAMPLE_START_TIME_UTC	The time at which pumping started for the sample	UTC
ACTUAL_DEPTH_m	The actual depth the sample was taken at. This value is the average depth over time time period spent sampling.	meters
VOLUME_FILTERED_L	The amount of seawater pumped during the sample	liters
TIME_SPENT_FILTERING_min	Actual time spent pumping (should match stop time)	minutes
VEHICLE_COMMENT	Vehicle comment	unitless
SUBMERGE_TIME_UTC	Time of last Iridium update before submerging	unitless
SUBMERGE_LAT	Latitude of last Iridium update before submerging	decimal degrees
SUBMERGE_LON	Longitude of last Iridium update before submerging	decimal degrees
SURFACE_TIME_UTC	Time of first Iridium update after surfacing (note that Clio could be on surface for a significant amount of time due to other ship operations before recovery)	unitless

SURFACE_LAT	Latitude of first Iridium update after surfacing (note that Clio could be on surface for a significant amount of time due to other ship operations before recovery)	decimal degrees
SURFACE_LON	Longitude of first Iridium update after surfacing (note that Clio could be on surface for a significant amount of time due to other ship operations before recovery)	decimal degrees
LAUNCH_TIME_UTC	Vehicle released from ship	unitless
RECOVERY_TIME_UTC	Vehicle back on deck	unitless
NOTES	Dive notes	unitless

[[table of contents](#) | [back to top](#)]

Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	AUV Clio
Generic Instrument Description	Clio is an autonomous underwater vehicle (AUV) created to accomplish the dual goals of global ocean mapping and biochemistry sampling. The ability to sample dissolved and particulate seawater biochemistry across ocean basins while capturing fine-scale biogeochemical processes sets it apart from other AUVs. Clio is designed to efficiently and precisely move vertically through the ocean, drift laterally to observe water masses, and integrate with research vessel operations to map large horizontal scales up to a depth of 6,000 meters. More information is available at https://www2.whoi.edu/site/deepsubmergencelab/clio/

[[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 $^{15}\text{NO}_2^-$ 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](#)]