Carbon system measurements, methane, nutrients, and sulfate concentrations from water column samples collected on R/V Rachel Carson cruise RC0107 in Clayoquot Sound, Vancouver Island, British Columbia during October 2023

Website: https://www.bco-dmo.org/dataset/992821
Data Type: Cruise Results
Version: 1
Version Date: 2026-01-22

Project
» CAREER: Cryptic sulfur cycling and organic matter preservation in marine oxygen deficient zones (Sulfur in Particles)

Contributors	Affiliation	Role
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Abstract
These data include carbon system measurements, methane, nutrients, and sulfate concentrations from water column samples collected on the R/V Rachel Carson cruise RC0107 between October 2nd and 8th, 2023 in Clayoquot Sound, Vancouver Island, British Columbia. Water samples were collected at multiple sites in Clayoquot Sound. CTD casts were conducted at numerous locations across the study area, and the corresponding CTD data are publicly available through the Rolling Deck to Repository (R2R). For sampling sites where water was collected, we provide data for the carbon system (DIC, pH, and alkalinity), methane, nutrients, and sulfate concentrations. These data will be valuable for those interested in carbon cycling and biogeochemistry in fjord systems. Samples were collected by Molly Crotteau, Morgan Raven, Aaron Martinez, Natalya Evans, Marianna Karagiannis, Jordan Fisburn, and Jaqui Neibauer. Data were interpreted by Morgan Raven and Molly Crotteau.

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Coverage

Location: Clayoquot Sound, Vancouver Island, British Columbia
Spatial Extent: **N**:49.22652 **E**:-125.597 **S**:49.16824 **W**:-125.6963
Temporal Extent: 2023-10-03 - 2023-10-06

Dataset Description

This dataset is one of three datasets presenting marine biogeochemistry data from four sites in Clayoquot Sound, Vancouver Island, British Columbia from water, sediment, and porewater samples that were collected aboard the R/V Rachel Carson in October 2023. These sites were selected because they represent hotspots of organic carbon burial spanning a range of geochemical conditions. They represent a range of oxic to historically anoxic water columns, and receive organic matter inputs varying from predominantly terrestrial to predominantly marine sources. Together, these datasets provide a framework to evaluate the controls and drivers of organic matter preservation in fjord sediments. See the "Related Datasets" section for the other datasets.

Methods & Sampling

Water samples were collected using a CTD with 12-liter (L) Niskin bottles from four sites in Clayoquot Sound, Vancouver Island, British Columbia in October 2023. To sample methane, 60 milliliters (mL) of unfiltered water was added to a 72 mL serum vial containing 2 NaOH pellets, sealed, and refrigerated until analysis. For DIC and pH samples, 0.2 micron (um) filtered water was added to exetainers; samples were refrigerated until analysis. To sample alkalinity, 0.2 micron filtered water was added to a 20 mL serum vial and sealed; samples were refrigerated until analysis. For nutrient samples, 0.2 micron filtered water was added to a falcon tube; samples were frozen at -20 degrees Celsius (°C) until analysis. To sample sulfate, 1 mL of 0.2 micron filtered water was added to a tube containing 100 microliters (uL) of 1 N HCl; sulfate samples were frozen at -20°C until analysis.

Methane was analyzed via GC-FID (Shimadzu GC14A). DIC and δ13C of DIC were analyzed at the UC Davis Stable Isotope Facility. Alkalinity was determined by titration of the sample with 0.03 M HCl (Metrohm 888 Titrando). Nutrients were analyzed by the MSI Analytical Lab at UC Santa Barbara. pH was determined using the dye meta-cresol purple via a UV-Vis spectrophotometer (Genesys 150) (Clayton and Byrne 1993). Sulfate was measured via ion chromatography (Metrohm 930 Compact IC Flex).

Samples analyzed in this study were collected within Ahousaht Territory, on the west coast of Vancouver Island, British Columbia. We respectfully acknowledge the Ahousaht Nation and the Maaqutusiis Hahoulthee Stewardship Society for their stewardship of these lands and for the opportunity to conduct research within their territory.

Data Processing Description

Sulfate concentrations were calibrated using a sulfate standard curve (0.1 – 100 parts per million (ppm)). Methane concentrations were calibrated using a standard curve (1.446 ppm – 50 ppm). Alkalinity was calibrated using CO2 in Seawater Reference Material (CRM) from Scripps Institution of Oceanography.

BCO-DMO Processing Description

- Imported original file "20251007_FJ_watercolumn.csv" into the BCO-DMO system.
- Removed "nd" from the dataset (missing data are empty/blank in the final csv file).
- Converted the date field to YYYY-MM-DD format.
- Saved the final file as "992821_v1_rc0107_water_column.csv".

Problem Description

Within the dataset, bdl = below detection limit

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Related Publications

Clayton, T. D., & Byrne, R. H. (1993). Spectrophotometric seawater pH measurements: total hydrogen ion concentration scale calibration of m-cresol purple and at-sea results. Deep Sea Research Part I: Oceanographic Research Papers, 40(10), 2115–2129. doi:10.1016/0967-0637(93)90048-8
Methods

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Related Datasets

IsRelatedTo

Crotteau, M., Raven, M. R., Martinez, A., Evans, N., Karagiannis, M., Fishburn, J., Neibauer, J. A. (2026) **Porewater geochemistry data from sediment cores collected on R/V Rachel Carson cruise RC0107 in Clayoquot Sound, Vancouver Island, British Columbia during October 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-01-21 http://lod.bco-dmo.org/id/dataset/992752 [view at BCO-DMO]

Crotteau, M., Raven, M. R., Martinez, A., Evans, N., Karagiannis, M., Fishburn, J., Neibauer, J. A. (2026) **Sediment geochemistry data from cores collected on R/V Rachel Carson cruise RC0107 in Clayoquot Sound, Vancouver Island, British Columbia during October 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-01-21 http://lod.bco-dmo.org/id/dataset/992723 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
site	Site number (52, 51.5, 47, or 48) where water sample was taken	unitless
latitude	Latitude of sampling location	decimal degrees
longitude	Longitude of sampling location	decimal degrees
date	Date sample was collected	unitless
depth	Sampling depth	meters
temp	Temperature	degrees Celsius
sal	Salinity	PSU
O2	Concentration of dissolved oxygen	micromole per kilogram

fluor	Fluorescence	milligram per meter cubed
SO4	Sulfate concentration	millimolar
DIC	Concentration of dissolved inorganic carbon	millimolar
d13C_DIC	13C to 12C ratio in dissolved inorganic carbon	per mille
pH	pH	unitless
Alk	Alkalinity	micromole per kilogram
CH4	Methane	nanomolar
PO4	Concentration of phosphate	micromolar
SiO4	Concentration of silicate	micromolar
NO2	Concentration of nitrite	micromolar
NO3	Concentration of nitrate	micromolar
NH3	Concentration of ammonia	micromolar

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Instruments

Dataset-specific Instrument Name	Metrosep A Supp 5 100/4.0 column and Metrohm 930 Compact IC Flex
Generic Instrument Name	Ion Chromatograph
Dataset-specific Description	Used to measure concentrations of sulfate.
Generic Instrument Description	Ion chromatography is a form of liquid chromatography that measures concentrations of ionic species by separating them based on their interaction with a resin. Ionic species separate differently depending on species type and size. Ion chromatographs are able to measure concentrations of major anions, such as fluoride, chloride, nitrate, nitrite, and sulfate, as well as major cations such as lithium, sodium, ammonium, potassium, calcium, and magnesium in the parts-per-billion (ppb) range. (from http://serc.carleton.edu/microbelife/research_methods/biogeochemical/ic....)

Dataset-specific Instrument Name	Metrohm 888 Titrando
Generic Instrument Name	Metrohm 888 Titrando pentiometric titrator
Dataset-specific Description	Used to measure alkalinity.
Generic Instrument Description	A modular pentiometric titrator for dynamic, monotonic and set endpoint titrations. The instrument consists of an intergrated buret, rod or magnetic stirrer and dosing system. Operation is carried out by means of a touch-sensitive display or with high-performance PC software. Temperature is measured by a Pt1000 or NTC. It has a measuring range of -13 to 20 pH, resolution of 0.001 pH and measuringaccuracy of +/-0.003 pH.

Dataset-specific Instrument Name	12 L Niskin bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Seawater samples were collected using a 12-bottle rosette with 12 L Niskin bottles.
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.

Dataset-specific Instrument Name	Shimadzu GC14A
Generic Instrument Name	Shimadzu GC-14 A gas chromatograph
Dataset-specific Description	Used to measure methane concentrations.
Generic Instrument Description	A fully programmable (time and temperature) gas chromatography system. Multi-linear programming capability using up to a maximum of five staged increments within a time maxima of 655 minutes. Programming and operational control is accomplished via the multifunctional interactive keypad. The keypad also provides for LED display of system parameters, program monitoring, file storage (10 separate file slots) and miscellaneous features. The flow control module includes four ports to accommodate detector gas components (air and hydrogen for Flame Ionization Detection) and carrier/makeup gas. All temperature zones (column oven, injector and detector) are overheat protected.

Dataset-specific Instrument Name	Genesys 150 UV-Vis Spectrophotometer
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	Used to measure pH.
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

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Deployments

RC0107

Website	https://www.bco-dmo.org/deployment/992743
Platform	R/V Rachel Carson (UW)
Start Date	2023-10-02
End Date	2023-10-08
Description	See more information from R2R: https://www.rvdata.us/search/cruise/RC0107

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Project Information

CAREER: Cryptic sulfur cycling and organic matter preservation in marine oxygen deficient zones (Sulfur in Particles)

Coverage: Eastern tropical North Pacific

NSF Award Abstract:

CAREER: Particle-Hosted Sulfur Cycling and Organic Matter Burial in Oxygen Deficient Zones

Areas of the ocean without dissolved oxygen are called anoxic zones. These environments are increasing due to human activities and climate change. Large amounts of organic carbon are buried in sediments below anoxic zones. However, we do not fully understand why organic carbon is preserved in these zones. This project seeks to understand a newly discovered process that may contribute to carbon preservation in anoxic zones. The process is called organic matter sulfurization. Through this process, organic matter is transformed and effectively ?pickled? by reacting with sulfide. Rapid sulfurization reactions were identified for the first time in sinking marine particles and may have larger effect on carbon burial in sediments than previously thought. This project will be the first to provide measurements of the scale and significance of rapid organic matter sulfurization in modern anoxic zones. This project includes field and laboratory studies. The research will involve a team of students, including a graduate student and six undergraduates, who will be supported through a peer mentorship program. Undergraduate researchers will be recruited from the inaugural class of a newly developed Practical Research Skills course (Earth 101A) at the University of California Santa Barbara. It seeks to help undergraduates develop critical thinking and observational skills that have broad applicability. This project will launch a self-sustaining and vigorous research program in marine biogeochemistry, heavily invested in undergraduate research education, with impacts that will outlast its five-year duration.

The overarching research goal of this project is to assess the contribution of sulfurization reactions to organic carbon preservation in anoxic environments. After constructing and testing a set of customized particle traps, an expedition will be conducted to the marine anoxic zone off the coast of Mexico. Sinking particles, suspended materials, and surface sediments will be collected at three sites on the Mexican shelf and slope, that have generally high local productivity and gradients in bottom-water oxygen concentration. In the field, the rates and isotopic fractionation of microbial sulfate reduction and organic sulfur formation will be measured with stable and radioactive isotope tracers. Subsequently, organic sulfur sources from both natural samples and laboratory experiments will be characterized using mass spectrometry, X-ray absorption spectroscopy, and other geochemical techniques. Together, the results of this work will identify the timing and location of organic matter sulfurization in this environment, which have substantial implications for both modeling marine carbon fluxes and interpreting the geologic record. This study will provide the first quantitative estimates of the scale of organic matter sulfurization in anoxic marine zones, its contribution to sedimentary carbon burial, and its sensitivities to environmental change. Simultaneously, this project will improve the Earth Science undergraduate curriculum at the University of California Santa Barbara through the development of a clear, supportive, and accessible mechanism for including students in research.

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-2143817

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