Porewater geochemical data from sediment cores collected at methane seeps and reference sites in mainstem Chesapeake Bay in July 2022

Website: https://www.bco-dmo.org/dataset/1005742
Data Type: Cruise Results
Version: 1
Version Date: 2026-09-09

Project
» Collaborative Research: Investigating the source and flux of dissolved organic carbon released from methane seeps to the deep-ocean (seepDOM)

Contributors	Affiliation	Role
Lapham, Laura L.	University of Maryland Center for Environmental Science (UMCES/CBL)	Co-Principal Investigator
Pohlman, John	United States Geological Survey (USGS)	Co-Principal Investigator
Hildebrand, Anna	University of Maryland Center for Environmental Science (UMCES/CBL)	Student
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
These data include vertical profiles of concentrations and stable carbon isotope values of methane, carbon dioxide, dissolved organic carbon (DOC), dissolved inorganic carbon (DIC), and total organic carbon (TOC) from porewater of sediment cores collected at methane seeps and reference sites. Sediment porosity and dissolved sulfate and chloride concentrations are also presented. Gravity cores (1 meter) were collected from the mainstem of Chesapeake Bay from July 25-29, 2022. These data are used to assess the distribution, source, and fate of methane in a eutrophic shallow-water estuary, which is a source of methane to the atmosphere. These data can be used to understand the processes driving methane release and constrain estuarine methane emissions. The sediment data are reported in a separate, related dataset.

Table of Contents

- Coverage
- Dataset Description
  - Methods & Sampling
  - Data Processing Description
  - BCO-DMO Curation Notes
- Data Files
- Related Publications
- Related Datasets
- Parameters
- Instruments
- Project Information
- Funding

Coverage

Location: Chesapeake Bay seafloor
Spatial Extent: **N**:39.27923481 **E**:-75.93866667 **S**:37.20698975 **W**:-76.44806787
Temporal Extent: 2022-07-25 - 2022-07-29

Methods & Sampling

Core collection: Cores were collected via a gravity corer (1 meter) in July 2022 during R/V Carson cruise CB22 (R/V Carson is operated by the University of Maryland Center for Environmental Science, https://www.umces.edu/research-fleet/).

Sediment and porewater extraction: For CH4, CO2, δ13C-CH4, δ13C-CO2, and porosity measurements, a cutoff 3 milliliter (mL) syringe was inserted into pre-drilled holes in the core liner at 5 centimeters (cm) resolution. Two 3 mL sediment plugs were taken for CH4/CO2, and a small scoop of sediment was taken for porosity and placed in a whirlpak bag. For porewater extraction, rhizons (19.21.23 F; Rhizosphere Research Products) were inserted into pre-drilled holes offset from the sediment holes in the core liner. A vacuum was pulled with an acid-clean 30 mL syringe to extract the porewater, then pipetted into respective containers for DIC, δ13C-DIC, DOC, δ13C-DOC, SO4, and Cl.

Sediment/porewater sampling:
CH4, CO2, δ13C-CH4, δ13C-CO2: 20 mL glass serum vials containing 3-6 mL sediment preserved with 5 mL saturated brine were subsampled using the headspace equilibration method following Magen et al. (2014). Briefly, 8 mL of ultra-zero purity air (UZA) was injected into the sediment vial with a plastic syringe equipped with a 22-gauge needle. Vials were shaken, and the headspace was mixed for 2 minutes, after which 8 mL of headspace gas sample was removed. Check standards for concentration were run approximately every 5 samples and corrected as described by Pohlman and others (2021). For samples measured by cavity ring-down spectroscopy, dissolved concentrations were calculated using the following equation:

((pCH4 * 10^-6 * Vg) / (R * T_extraction) + (Vw * pCH4 * 10^-6 * Sol_CH4)) / Vw * 10^6 = [CH4]

Where pCH4 is the headspace concentration of methane in ppm, Vg is the volume of gas sample in mL, R is the gas constant in L-atm/mol-K, T_extraction is the extraction temperature in Kelvin, Vw is the volume of water sample that was extracted in mL, Sol_CH4 is the solubility of methane in mol/L-atm (Wiesenburg & Guinasso, 1979; Yamamoto et al., 1976), and [CH4] is the dissolved concentration of methane in the original natural water sample, in micromoles per liter.

Porosity: Fresh sediment was placed in whirlpak bags, sealed, and refrigerated until measurement in the lab. Sediment was weighed, placed in a drying oven (45 degrees Celsius, 1 week), then weighed again. Petri dishes with dried sediment were weighed again. The difference between the wet and dry sediment is the water weight, and the ratio of the water volume to the total volume is the porosity, assuming a dry bulk density of 2.5.

DIC and δ13C-DIC: 1 mL porewater was injected into a helium-filled 12 mL exetainer vial pre-filled with 1mL 85% phosphoric acid. The stable carbon isotope ratios and concentrations were determined from CO2 by isotope ratio mass spectrometry. Measurements are standardized with lithium carbonate reference material, and isotope ratios are reported in the standard d-notation relative to VPDB.

DOC and δ13C-DOC: 40 mL amber VOA vials containing 1 mL porewater sample acidified to pH 2 with trace metal clean HCl were measured with the wet oxidation method, similarly to the setup detailed in Lalonde et al. (2014). Samples are acidified and sparged to remove inorganic carbon then reacted with Sodium persulfate as wet oxidation. Data was normalized using two different internal organic standards (precision ± 0.5 ppm for concentrations and 0.2‰ for isotopes).

SO4 and Cl: 2 mL microcentrifuge tubes containing 40 uL porewater sample acidified to pH 2 with 0.1M H3PO4 were diluted (135x) with Milli-Q water prior to analysis. IAPSO certified seawater standards (Ocean Scientific International Ltd.) were used for all samples and precision is ±1.5%.

TOC and δ13C-TOC: Sediment samples from all cruises were dried at 60 degrees C for three days, then ground with a mortar and pestle. Homogenized sediment was weighed into silver capsules for acid fumigation. Samples were acid fumigated to remove carbonate and dried at 60 degrees Celsius for 2-4 hours, then wrapped into tin capsules. Samples were run on an elemental analyzer interfaced with an isotope ratio mass spectrometer. Samples were normalized to an acetanilide, protein, and bass standard calibrated to standards USGS 40 and USGS 41. Stable carbon isotope values are reported in d notation relative to VPDB.

Data Processing Description

Methane, carbon dioxide, and dissolved inorganic carbon concentrations and stable carbon isotope ratios: Software for Picarro was used to obtain the CH4, CO2, and DIC concentrations (ppm) as well as stable carbon isotope ratios (delta notation; per mille). Concentrations were converted to dissolved concentrations (mM) and stable carbon isotope ratios were corrected for the machine offset using Microsoft Excel.

Sulfate and chloride: Chromeleon 7 software was used to obtain areas for SO4 and Cl. Areas were converted to concentrations (mM) using Microsoft Excel.

Particulate organic carbon concentrations and stable carbon isotope ratios: EAS Clarity 3.0.0.154 and Isodat Acquisition Version 3.0 were used to obtain POC concentrations (%) and stable carbon isotope ratios (delta notation; per mille). Concentrations and stable carbon isotope ratios were corrected for machine drift using Microsoft Excel.

BCO-DMO Curation Notes

- Imported original file "1005742_v2_porewater_geochem_cb.csv" into the BCO-DMO data processing system.
- Converted "Sampling_Date" column from string format %m/%d/%Y to date type with output format %Y-%m-%d.
- Saved the final file as "1005742_v1_porewater_geochem_cb.csv".

[table of contents | back to top]

Data Files

File	
1005742_v1_porewater_geochem_cb.csv	(Comma Separated Values (.csv), 31.16 KB) MD5:ce84c5e01e722d3ccc232fc3ea7c81fd
Primary data file for dataset ID 1005742, version 1	

[table of contents | back to top]

Related Publications

Lalonde, K., Middlestead, P., & Gélinas, Y. (2014). Automation of 13C/12C ratio measurement for freshwater and seawater DOC using high temperature combustion. Limnology and Oceanography: Methods, 12(12), 816–829. Portico. https://doi.org/10.4319/lom.2014.12.816
Methods

Magen, C., Lapham, L. L., Pohlman, J. W., Marshall, K., Bosman, S., Casso, M., & Chanton, J. P. (2014). A simple headspace equilibration method for measuring dissolved methane. Limnology and Oceanography: Methods, 12(9), 637–650. doi:10.4319/lom.2014.12.637
Methods

Wiesenburg, D. A., & Guinasso, N. L. (1979). Equilibrium solubilities of methane, carbon monoxide, and hydrogen in water and sea water. Journal of Chemical & Engineering Data, 24(4), 356–360. https://doi.org/10.1021/je60083a006
Methods

Yamamoto, S., Alcauskas, J. B., & Crozier, T. E. (1976). Solubility of methane in distilled water and seawater. Journal of Chemical & Engineering Data, 21(1), 78–80. https://doi.org/10.1021/je60068a029
Methods

[table of contents | back to top]

Related Datasets

IsRelatedTo

Lapham, L. L., Hildebrand, A., Pohlman, J. (2026) **Sediment geochemical data from sediment cores collected at methane seeps and reference sites in mainstem Chesapeake Bay in July 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-08-20 doi:10.26008/1912/bco-dmo.1002503.1 [view at BCO-DMO]

[table of contents | back to top]

Parameters

Parameter	Description	Units
Sample_ID	Sample ID. Sample IDs are numbers given to each sediment sub-sample when collected	unitless
Site_Name	Site name for sample collection	unitless
Station_ID	Station ID for sample collection	unitless
Latitude_ddeg	Sample latitude, south is negative	decimal degrees
Longitude_ddeg	Sample longitude, west is negative	decimal degrees
Sampling_Date	Date the sample was collected	unitless
Water_Depth_m	Depth of the seafloor relative to the sea surface at the sample location	meters (m)
Core_Allocation	Core Allocation. Core allocations were for specific project needs. Geochem = geochemical characterization; Radionuclide = radionuclide measurements and associated geochemistry	unitless
Sediment_Depth_cmbsf	Mid-depth of core sub-section relative to the sediment water interface	centimeters below sea floor (cmbsf)
Sediment_interval_thickness_cm	Sediment interval thickness of the collected sample	centimeters (cm)
Sulfate_mM	Pore water dissolved sulfate	millimolar (mM)
Chloride_mM	Pore water dissolved chloride	millimolar (mM)
DIC_mM	Pore water dissolved inorganic carbon	millimolar (mM)
d13C_DIC_permille	Bulk stable carbon isotope value of pore water dissolved inorganic carbon relative to Vienna Pee Dee Belemnite (VPDB)	per mille (‰)
Porosity	Sediment water content relative to solid material	unitless

CH4_uM	Pore water dissolved methane	micromolar (uM)
d13C_CH4_permille	Bulk stable carbon isotope value of pore water methane relative to Vienna Pee Dee Belemnite (VPDB)	per mille (‰)
d13C_CH4_1sigma	One sigma associated with the bulk stable carbon isotope value of pore water dissolved methane measurement	per mille (‰)
CO2_mM	Pore water dissolved carbon dioxide	millimolar (mM)
d13C_CO2_permille	Bulk stable carbon isotope value of pore water dissolved carbon dioxide relative to Vienna Pee Dee Belemnite (VPDB)	per mille (‰)
d13C_CO2_1sigma	One sigma associated with the bulk stable carbon isotope value of pore water dissolved carbon dioxide measurement	per mille (‰)
DOC_mM	Pore water dissolved organic carbon	millimolar (mM)
d13C_DOC_permille	Bulk stable carbon isotope value of pore water dissolved organic carbon relative to Vienna Pee Dee Belemnite (VPDB)	per mille (‰)
Comment	Comments related to the sample collected such as physical appearance	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Costech ECS 4010 elemental analyzer
Generic Instrument Name	Costech International Elemental Combustion System (ECS) 4010
Dataset-specific Description	Total organic carbon and stable carbon isotopes were measured with a Costech ECS 4010 elemental analyzer equipped with a thermal conduction detector and connected to a continuous flow isotope ratio mass spectrometer Delta V Plus (Thermo Scientific) using He as the carrier gas at Chesapeake Biological Laboratory.
Generic Instrument Description	The ECS 4010 Nitrogen / Protein Analyzer is an elemental combustion analyser for CHNSO elemental analysis and Nitrogen / Protein determination. The GC oven and separation column have a temperature range of 30-110 degC, with control of +/- 0.1 degC.

Dataset-specific Instrument Name	gravity corer
Generic Instrument Name	Gravity Corer
Dataset-specific Description	Cores were collected via a gravity corer (1 m).
Generic Instrument Description	The gravity corer allows researchers to sample sediment layers at the bottom of lakes or oceans. The coring device is deployed from the ship and gravity carries it to the seafloor. From: http://www.whoi.edu/instruments/viewInstrument.do?id=1079

Dataset-specific Instrument Name	Thermo Scientific Aquion ion chromatograph
Generic Instrument Name	Ion Chromatograph
Dataset-specific Description	Sulfate and chloride was measured with a Thermo Scientific Aquion ion chromatograph (IonPac AG22 4x50 mm guard column, IonPac AS22 4x250 mm analytical column, and AERS 300 4 mm suppressor) with an AS40 Autosampler shipboard and at Chesapeake Biological Laboratory.
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	ThermoFinnigan Delta S & Delta V Plus
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	DIC concentrations and carbon isotope values measured using a GasBench II system interfaced with a Delta V Plus isotope ratio mass spectrometer at the University of California Davis Stable Isotope Facility.
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	ThermoFinnigan DELTAplus XL
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	DOC_uM and DOC_d13C_permille: d13C-DOC values were quantified using a ThermoFinnigan DELTAplus XL Isotope Ratio Mass Spectrometer interfaced to the Aurora 1030C following the method of Lalonde and others (2014).
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	AS40 Autosampler
Generic Instrument Name	Laboratory Autosampler
Dataset-specific Description	Sulfate and chloride was measured with a Thermo Scientific Aquion ion chromatograph (IonPac AG22 4x50 mm guard column, IonPac AS22 4x250 mm analytical column, and AERS 300 4 mm suppressor) with an AS40 Autosampler shipboard and at Chesapeake Biological Laboratory.
Generic Instrument Description	Laboratory apparatus that automatically introduces one or more samples with a predetermined volume or mass into an analytical instrument.

Dataset-specific Instrument Name	Picarro G2201-i CRDS
Generic Instrument Name	Picarro G2201-i isotope analyzer
Dataset-specific Description	Dissolved methane and carbon dioxide concentrations and stable carbon isotopes were determined using a Picarro G2201-i CRDS at US Geological Survey.
Generic Instrument Description	The G2201-i Isotopic Analyzer measures d13C for CH4 and CO2. See: https://www.picarro.com/products/g2201i_isotopic_analyzer

Dataset-specific Instrument Name	GasBench II
Generic Instrument Name	Thermo-Fisher Scientific Gas Bench II
Dataset-specific Description	DIC concentrations and carbon isotope values measured using a GasBench II system interfaced with a Delta V Plus isotope ratio mass spectrometer at the University of California Davis Stable Isotope Facility.
Generic Instrument Description	An on-line gas preparation and introduction system for isotope ratio mass spectrometry that is designed for high precision isotope and molecular ratio determination of headspace samples, including water equilibration, carbonates and atmospheric gases. The instrument allows for the use of a dual viscous flow inlet system of repetitive measurements of sample and standard gas on a continuous flow isotope ratio mass spectrometer (CF-IRMS) system. The sample volume is the sample vial (instead of a metal bellows), and the reference gas volume is a pressurized gas tank. The instrument consists of a user programmable autosampler, a gas sampling system, a maintenance-free water removal system, a loop injection system, an isothermal gas chromatograph (GC), an active open split interface, a reference gas injection system with three reference ports, and one or two optional LN2 traps for cryofocusing. The gas sampling system includes a two port needle which adds a gentle flow of He into the sample vial, diluting and displacing sample gas. Water is removed from the sample gas through diffusion traps. The loop injector aliquots the sample gas onto the GC column, which separates the molecular species. The reference gas injection system allows accurate referencing of each sample aliquot to isotopic standards. The system can be used with several options including a carbonate reaction kit that allows injection of anhydrous phospohric acid into sample vials. Note "Finnigan GasBench-II" is the previous brand name of this instrument.

Dataset-specific Instrument Name	Aurora 1030C
Generic Instrument Name	Total Organic Carbon Analyzer
Dataset-specific Description	d13C-DOC values were quantified using a ThermoFinnigan DELTAplus XL Isotope Ratio Mass Spectrometer interfaced to the Aurora 1030C following the method of Lalonde and others (2014).
Generic Instrument Description	A unit that accurately determines the carbon concentrations of organic compounds typically by detecting and measuring its combustion product (CO2). See description document at: http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/bs116.pdf

[table of contents | back to top]

Project Information

Collaborative Research: Investigating the source and flux of dissolved organic carbon released from methane seeps to the deep-ocean (seepDOM)

Website: https://sites.google.com/umces.edu/thelaphamlab/home/projects/seepdoc

Coverage: Astoria Canyon and Hydrate Ridge

NSF Award Abstract:
Dissolved organic carbon (DOC) is a key component of the ocean's food web and carbon cycle, and carbon exchanged between oceanic DOC and the atmosphere has influenced atmospheric CO2 levels on timescales

ranging from recent decades to the geologic past. Production by marine algae in the surface ocean is the largest source of DOC and its effects on the ocean carbon cycle are widely appreciated. However, the contribution of DOC from additional sources such as rivers, hydrothermal vents, and methane seeps and their impact on ocean ecology and chemistry are not well understood. Each source differs in terms of its biological utilization and age, which affects the storage and distribution of DOC among the ocean basins. Methane seeps located along continental margins are particularly significant because they may transfer globally significant quantities of carbon stored below the seafloor as natural gas and gas hydrate to the oceans. This project will investigate the production, flux, composition and potential for biological utilization of DOC at Hydrate Ridge, located offshore Oregon. Hydrate Ridge is a prominent methane seep with massive accumulations of gas hydrate and a node of the Ocean Observatories Initiative telecommunications cabled array on the Juan De Fuca tectonic plate, which provides a continuous stream of real-time regional oceanographic data. We will sample and chemically characterize methane, DOC, and other materials to provide information about where the materials originated (deep vs shallow), how they have been chemically altered, to what extent they may feed deep ocean organisms, or contribute to the long term storage of DOC in the ocean. Experiments and analysis will be conducted using sediment cores and bottom water samples collected using either the remotely operated vehicle Jason or the human occupied vehicle Alvin during a 7-day ocean expedition. Additionally, this project will place osmotically-driven pumps on the seafloor to continuously sample fluids for approximately one year, thereby allowing us to monitor the movement of methane and DOC expelled from the seafloor to the ocean and constrain processes that regulate the release of carbon to the oceans at methane seeps. This project will support one graduate student and several undergraduates from a community college in Maryland and a college located in a lower-income urban center in southeastern Massachusetts. We will disseminate project findings to the public with a series of videos for public TV.

This study will investigate the production, flux and reactivity of methane-derived dissolved organic carbon (DOC) from methane (CH4) seeps at Hydrate Ridge, Offshore Oregon. The study will address four fundamental questions to determine the significance of CH4-derived DOC within the ocean carbon cycle: (1) How much CH4-derived fossil DOC do seeps contribute to the oceans? (2) To what extent is CH4-derived C incorporated into DOC during anaerobic oxidation of CH4? (3) Is seep DOC bioavailable or recalcitrant when released into the deep ocean? (4) How does the flux of DOC to the water column vary over time? We will employ an interdisciplinary strategy that includes in situ sampling, laboratory incubations, and a comprehensive analytical geochemistry program. Data from the Ocean Observatories Initiative Regional Cabled Array at Southern Hydrate Ridge will be used to provide context for field and experimental data. The composition and abundance of organic and inorganic chemical species along with the stable and radiocarbon isotope composition of pore water, bulk sediment, and water column C pools will be used to identify DOC sources and quantify fluxes from cold seeps characterized by a range of advection rates. The centerpiece of the investigation will be a 7-day research cruise to Hydrate Ridge to collect sediments, pore fluids, and water column samples, and deploy OsmoSamplers for continuous time series fluid sampling. The results will form the foundation for estimating the contribution of CH4-derived DOC to the oceanic DOC pool.

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-2049517

[table of contents | back to top]