Porewater dissolved organic carbon and associated geochemical data for methane seeps in the Cascadia Margin: Astoria Canyon, Barkley Canyon, Hydrate Ridge, and Bullseye Vent

Website: https://www.bco-dmo.org/dataset/959765
Data Type: Other Field Results
Version: 1
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Project
» Collaborative Research: Investigating the source and flux of dissolved organic carbon released from methane seeps to the deep-ocean (seepDOM)

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Abstract

These data include vertical profiles of concentrations and stable carbon isotope values of dissolved organic carbon (DOC), dissolved inorganic carbon (DIC), total organic carbon (TOC) from sediment cores collected at methane seeps and reference sites. Sediment porosity and dissolved sulfate and methane concentrations are also presented. Methane seeps in Astoria Canyon, Barkley Canyon, Hydrate Ridge, and Bullseye Vent, along the Cascadia Margin, were sampled. These data were collected over two decades and across four cruises: PGC02-08 (CCGS John P. Tully, 2002), Hydrates 2004 Sea Trial (CCGS John P. Tully, 2004), AT50-14 (R/V Atlantis, 2023), and AT50-29B (R/V Atlantis, 2024). These data are used to assess the prevalence of methane-derived DOC at methane seeps, which may contribute ‘old’ carbon to the deep ocean or serve as a source of reduced carbon for the deep ocean microbial loop.

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Coverage

Location: Cascadia Margin seafloor:Astoria Canyon: 46.2 N 124.6 W depth 727-847 m, Barkley Canyon: 48.3 N 126.1 W depth 855-857 m, Hydrate Ridge: 44.6 N 125.1 W depth 772-800 m, Bullseye Vent: 48.7 N 126.8 W depth 1268-1282 m
Spatial Extent: **N**:48.671875 **E**:-124.6027 **S**:44.568359 **W**:-126.849944
Temporal Extent: 2002-10-05 - 2024-08-22

Dataset Description

The NSF (OCE-2049517) funded ship time, SO4, H2S, DIC, d13C-DIC measurements and partially funded CH4, DOC and d13C-DOC measurements

The DOE NETL interagency agreement with the USGS (#89243320SFE000013) partially funded CH4 measurements

The USGS Mendenhall Research Fellowship Program partially funded DOC and d13C-DOC measurements, and funded TOC and d13C-TOC measurements

Methods & Sampling

Sediment and porewater handling:

PCG02-08- Core material was sectioned and pressure-squeezed with a modified Reeburgh squeezer (Reeburgh, 1967) into acid-washed all-plastic syringes. Porewater was then filtered through 0.45 um polyethersulphone syringe filters.

Hydrates2004- Core material was sectioned and pressure-squeezed with a modified Reeburgh squeezer (Reeburgh, 1967) into acid-washed all-plastic syringes. Porewater was then filtered through 0.2 um arodisc polyethersulphone syringe filters.

AT50-14- Core material was sectioned and pressure-squeezed with a modified Reeburgh squeezer (Reeburgh, 1967) into acid-washed all-plastic syringes. Porewater was then filtered through pre-combusted 0.4 um glass fiber filters.

AT50-29B- Core material was sectioned into acid-washed falcon tubes and refrigerated. Porewater was extracted using Rhizons with a 0.2 um filter size.

Porosity: Fresh sediment was placed in pre-weighed petri-dishes, sealed, and refrigerated until measurement in lab. Petri dishes were weighed upon return to shore, then were played in a drying oven (45°C, 1 week). 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.

SO4_mM: 0.5 mL porewater was sub-sampled into 2mL microcentrifuge tubes and dosed with 50 uL 0.1M phosphoric acid. Samples were measured using ion chromatography. IAPSO certified seawater was used for standardization, and precision is ±1.5%.

CH4_uM: Sediment plugs (volume = 3-6 cm3) were sampled and stored in serum bottles sealed with 1-cm-thick butyl rubber septa. 5mL of saturated brine was added to the serum bottles and shaken to equilibrate the headspace. The samples were refrigerated until analysis. For cruises PCG02-08, Hydrates2004, and AT50-14, methane concentrations of serum bottle headspaces were determined by gas chromatography flame ionization detection. These headspace concentrations were used to calculate dissolved concentrations of methane in porewater. For samples measured by GC, dissolved concentrations were calculated following

Hoehler et al. (2000).

For cruise AT50-29B, methane concentrations were determined using cavity ringdown spectroscopy. 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.

DOC_uM and DOC_d13C_permille: Samples (2-4 mL) were stored in combusted borosilicate glass vials with acid-cleaned teflon-lined septa caps. Vials were pretreated with 20 percent hydrochloric acid (12 microliters per milliliter of sample) to decrease the pH of the sample to 2 or less, and samples were stored at 4 degrees Celsius until analysis. Concentrations were determined with a TOC Analyzer using wet chemical oxidation (cruises PGC02-08 and Hydrates2004) (Heuer et al., 2009; Pohlman et al., 2011) and high temperature catalytic oxidation (cruises AT50-14 and AT50-29B) to convert DOC to CO2. For all cruises, nondispersive infrared detection was used to quantify this CO2. Potassium hydrogen phthalate (KHP) calibration standards were run to quantify DOC concentration. Stable carbon isotopes (d13C-DOC) were measured by isotope ratio mass spectrometry. Stable carbon isotope ratios are reported in standard delta notation relative to Vienna Pee Dee Belemnite (VPDB). Quality assurance included replicate analysis of natural reference materials, field samples and calibration standards. Uncertainty in DOC concentration was 5 percent or less, and uncertainty in d13C was 0.2 permille or less, based on replicate measurements.

DIC_mM and DIC_d13C_permille: Samples for DIC concentration for cruises PCG02-08 and Hydrates2004 were collected as 2 mL aliquots in 5 ml serum vials, sealed with butyl rubber septa, and quantified by coulometry. Samples for stable carbon isotopes (d13C-DIC) for cruises PGC02-08 and Hydrates2004 were collected as 1 ml aliquots in 2 ml serum vials, sealed with butyl rubber septa and analyzed as CO2 by isotope ratio mass spectrometry following acidification of the sample (Pohlman et al., 2013). Samples for DIC concentration and stable carbon isotopes for DIC for cruises AT-50-14 and AT50-29B were collected by injecting 1mL porewater 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.

TOC_wt.% and TOC_d13C_permille: Sediment samples from all cruises were freeze-dried and 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 45°C for 24 hours, then wrapped into tin capsules. Samples were run on an elemental analyzer interfaced with an isotope ratio mass spectrometer. Samples from PGC02-08 were normalized to an acetanilide standard and samples from AT50-14 were run with a peptone reference material, as well as standards USGS 40 226 and USGS 41. Stable carbon isotope values are reported in d notation relative to VPDB.

H2S_mM: Porewater sulfide (ΣH2S) was determined by sparging the sample aliquot after acidification with 25 % phosphoric acid, and trapping evolved H2S in sulfide antioxidant buffer (SAOB) solution for measurement with a sulfide specific electrode. Standards were prepared from a sodium bisulfide stock solution that was titrated with lead nitrate to determine its concentration, daily. Also on a daily basis, the stock solution was serially diluted with SAOB solution to produce a five-level calibration.

Data Processing Description

Sampling for this dataset includes push-coring, video-guided multi-coring, and piston coring. Samples from cruise PGC02-08 were collected by piston coring, and horizontal positioning information for cores was achieved with an acoustic bottom transponder constellation, which provided an accuracy of 1-2 meters. Samples from cruise Hydrates2004 were collected by push-coring using the ROV ROPOS. Samples from cruise AT50-14 were collected by push-coring using the HOV Alvin, and by video-guided multi-coring (sample IDs containing ‘MUC’). Samples from cruise AT50-29B were collected by push-coring using the ROV Jason.

SO4_mM: For cruises PGC02-08 and Hydrates2004 sulfate was measured using a Dionex DX-120 ion chromatograph equipped with a 4 mm AS-9HC column. For cruises AT50-14 and AT50-29B sulfate 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.

CH4_uM: For cruises PGC02-08 and Hydrates2004 methane was measured by gas chromatography using a Shimadzu GC 14-A and flame-ionization detector. For cruise AT50-14 samples were measured using an Agilent 6890 Gas Chromatograph with a Flame Ionization Detector and fitted with a HaySep Q packed column, 1/8”, 80/100 Mesh, 6ft long, operated at a constant flow of 20 ml/min. Samples were injected with a modified sample loop. For samples from AT50-29B, a Picarro G2201-i CRDS was used.

DOC_uM and DOC_d13C_permille: For cruises PGC02-08 and Hydrates2004 samples were measured on an OI Analytical 1010 TOC analyzer with a nondispersive infrared detector interfaced to a ThermoFinnigan DELTAplus XP mass spectrometer. For cruises AT50-14 and AT50-29B DOC samples were analyzed on an O.I. Analytical Aurora 1030C auto-analyzer by high temperature catalytic oxidation and quantified with a nondispersive infrared detector. 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).

DIC_mM and DIC_d13C_permille: For cruises PGC02-08 and Hydrates2004 DIC concentrations were determined using a model 5011 UIC carbon dioxide coulometer, and stable carbon isotope ratios were determined using a ThermoFinnigan Delta S isotope ratio mass spectrometer. For cruises AT50-14 and AT50-29B, 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.

TOC_wt.% and TOC_d13C_permille: For cruise PGC02-08, TOC content and carbon isotope values were quantified using a Fisons EA-1100 Elemental Analyzer interfaces to a ThermoFinnigan Delta Plus XP isotope ratio mass spectrometer. For cruise AT50-14, TOC content and carbon isotope values were quantified using a Thermo Flash Elemental Analyzer interfaced with a Delta V Plus isotope ratio mass spectrometer at the Alaska Stable Isotope Facility.

H2S_mM: Sulfide was measured with a Cole-Parmer Silver/Sulfide Ion-Selective Electrode (27502-41)

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Data Files

File
959765_v1_geochemical.csv(Comma Separated Values (.csv), 15.46 KB) MD5:143e3efc3d2a0f56dbf87358303844b8 Primary data file for dataset ID 959765, version 1

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Related Publications

Heuer, V. B., Pohlman, J. W., Torres, M. E., Elvert, M., & Hinrichs, K.-U. (2009). The stable carbon isotope biogeochemistry of acetate and other dissolved carbon species in deep subseafloor sediments at the northern Cascadia Margin. Geochimica et Cosmochimica Acta, 73(11), 3323–3336. doi:10.1016/j.gca.2009.03.001
Methods

Hoehler, T. M., Borowski, W. S., Alperin, M. J., Rodriguez, N. M., & Paull, C. K. (2000). Model, stable isotope, and radiotracer characterization of anaerobic methane oxidation in gas hydrate-bearing sediments of the Blake Ridge. Proceedings of the Ocean Drilling Program, 164 Scientific Results. https://doi.org/10.2973/odp.proc.sr.164.242.2000
Methods

Pohlman, J. W., Bauer, J. E., Waite, W. F., Osburn, C. L., & Chapman, N. R. (2010). Methane hydrate-bearing seeps as a source of aged dissolved organic carbon to the oceans. Nature Geoscience, 4(1), 37–41. https://doi.org/10.1038/ngeo1016
Methods

Pohlman, J. W., Riedel, M., Bauer, J. E., Canuel, E. A., Paull, C. K., Lapham, L., Grabowski, K. S., Coffin, R. B., & Spence, G. D. (2013). Anaerobic methane oxidation in low-organic content methane seep sediments. Geochimica et Cosmochimica Acta, 108, 184–201. https://doi.org/10.1016/j.gca.2013.01.022
Methods

Pohlman, J., & Casso, M. (2021). *Comparison of methane concentration and stable carbon isotope data for natural samples analyzed by discrete sample introduction module - cavity ring down spectroscopy (DSIM-CRDS) and traditional methods* [Data set]. U.S. Geological Survey. https://doi.org/10.5066/P99B34V1
Methods

REEBURGH, W. S. (1967). AN IMPROVED INTERSTITIAL WATER SAMPLER1. Limnology and Oceanography, 12(1), 163–165. Portico. https://doi.org/10.4319/lo.1967.12.1.0163
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

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Parameters

Parameter	Description	Units
Region	General sampling location within the Cascadia Margin (Astoria Canyon, Barkley Canyon, Hydrate Ridge, Bullseye Vent)	unitless
Cruise	Cruise ID for sample collection	unitless
SamplingDate	Date the sample was collected	yyyy-mm-dd
CoreID	Core ID. Core IDs are specific letter and number combinations given to cores when collected, and are specific to each individual cruise	unitless
SampleID	Sample ID. Sample IDs are numbers given to each sediment sub-sample when collected, and are specific to each individual cruise	unitless
CoreType	Core type (seep= collected in a methane seep, reference = collected outside a methane seep)	unitless
Latitude	Sample latitude, south is negative	decimal degrees
Longitude	Sample longitude, west is negative	decimal degrees
WaterDepth_m	Depth of the seafloor relative to the sea surface at the sample location	meters (m)

MidDepth_cmbsf	Mid-depth of core sub-section relative to the sediment water interface	centimeters below sea floor (cmbsf)
porosity	Sediment water content relative to solid material	unitless
SO4_mM	Pore water dissolved sulfate	millimolar (mM)
CH4_uM	Pore water dissolved methane	micromolar (uM)
DOC_uM	Pore water dissolved organic carbon	micromolar (uM)
DOC_d13C_permil	Bulk stable carbon isotope value of pore water dissolved organic carbon relative to Vienna Pee Dee Belemnite (VPDB)	per mille (‰)
DIC_mM	Porewater dissolved inorganic carbon	millimolar (mM)
DIC_d13C_permil	Bulk stable carbon isotope value of porewater dissolved inorganic carbon relative to Vienna Pee Dee Belemnite (VPDB)	per mille (‰)
TOC_wt_perc	sediment total organic carbon content	weight percent (wt.%)
TOC_d13C_permil	Bulk stable carbon isotope value of sediment total organic carbon content relative to Vienna Pee Dee Belemnite (VPDB)	per mille (‰)
H2S_mM	Pore water dissolved sulfide	millimolar (mM)

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Instruments

Dataset-specific Instrument Name	Picarro G2201-i
Generic Instrument Name	Cavity enhanced absorption spectrometers
Dataset-specific Description	CH4- Picarro G2201-i Cavity ringdown spectroscopy
Generic Instrument Description	Instruments that illuminate a sample inside an optical cavity, typically using laser light, and measure the concentration or amount of a species in gas phase by absorption spectroscopy. Techniques include cavity ring-down spectroscopy (CRDS) and integrated cavity output spectroscopy (ICOS).

Dataset-specific Instrument Name	model 5011 UIC
Generic Instrument Name	CO2 Coulometer
Dataset-specific Description	DIC_mM and DIC_d13C_permille: For cruises PGC02-08 and Hydrates2004 DIC concentrations were determined using a model 5011 UIC carbon dioxide coulometer,
Generic Instrument Description	A CO2 coulometer semi-automatically controls the sample handling and extraction of CO2 from seawater samples. Samples are acidified and the CO2 gas is bubbled into a titration cell where CO2 is converted to hydroxyethylcarbonic acid which is then automatically titrated with a coulometrically-generated base to a colorimetric endpoint.

Dataset-specific Instrument Name	Fisons EA-1100
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	TOC_wt.% and TOC_d13C_permille: For cruise PGC02-08, TOC content and carbon isotope values were quantified using a Fisons EA-1100 Elemental Analyzer interfaces to a ThermoFinnigan Delta Plus XP isotope ratio mass spectrometer.
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Dataset-specific Instrument Name	Thermo Flash
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	TOC_wt.% and TOC_d13C_permille: For cruise AT50-14, TOC content and carbon isotope values were quantified using a Thermo Flash Elemental Analyzer interfaced with a Delta V Plus isotope ratio mass spectrometer at the Alaska Stable Isotope Facility.
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Dataset-specific Instrument Name	Shimadzu GC 14 & Agilent 6890
Generic Instrument Name	Gas Chromatograph
Dataset-specific Description	CH4_uM: For cruises PGC02-08 and Hydrates2004 methane was measured by gas chromatography using a Shimadzu GC 14-A and flame-ionization detector. For cruise AT50-14 samples were measured using an Agilent 6890 Gas Chromatograph with a Flame Ionization Detector and fitted with a HaySep Q packed column, 1/8”, 80/100 Mesh, 6ft long, operated at a constant flow of 20 ml/min. Samples were injected with a modified sample loop. For samples from AT50-29B, a Picarro G2201-i CRDS was used.
Generic Instrument Description	Instrument separating gases, volatile substances, or substances dissolved in a volatile solvent by transporting an inert gas through a column packed with a sorbent to a detector for assay. (from SeaDataNet, BODC)

Dataset-specific Instrument Name	Dionex DX-120 & hermo Scientific Aquion
Generic Instrument Name	Ion Chromatograph
Dataset-specific Description	For cruises PGC02-08 and Hydrates2004 sulfate was measured using a Dionex DX-120 ion chromatograph equipped with a 4 mm AS-9HC column. For cruises AT50-14 and AT50-29B sulfate 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.
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 DELTAplus XL
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	DOC_uM and DOC_d13C_permille: For cruises AT50-14 and AT50-29B DOC, 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	ThermoFinnigan Delta S & Delta V Plus
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	DIC_mM and DIC_d13C_permille: For cruises PGC02-08 and Hydrates2004 DIC concentrations were determined using a model 5011 UIC carbon dioxide coulometer, and stable carbon isotope ratios were determined using a ThermoFinnigan Delta S isotope ratio mass spectrometer. For cruises AT50-14 and AT50-29B, 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	AS40
Generic Instrument Name	Laboratory Autosampler
Dataset-specific Description	For cruises AT50-14 and AT50-29B sulfate 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.
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	ThermoFinnigan DELTAplus XP
Generic Instrument Name	Mass Spectrometer
Dataset-specific Description	DOC_uM and DOC_d13C_permille: For cruises PGC02-08 and Hydrates2004 samples were measured on an OI Analytical 1010 TOC analyzer with a nondispersive infrared detector interfaced to a ThermoFinnigan DELTAplus XP mass spectrometer.
Generic Instrument Description	General term for instruments used to measure the mass-to-charge ratio of ions; generally used to find the composition of a sample by generating a mass spectrum representing the masses of sample components.

Dataset-specific Instrument Name	GasBench II system
Generic Instrument Name	Thermo-Fisher Scientific Gas Bench II
Dataset-specific Description	DIC- GasBench II system interfaced with a Delta V Plus isotope ratio mass spectrometer
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	O.I. Analytical Aurora 1030C
Generic Instrument Name	Total Organic Carbon Analyzer
Dataset-specific Description	DOC- O.I. Analytical Aurora 1030C
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

Dataset-specific Instrument Name	OI Analytical 1010
Generic Instrument Name	Total Organic Carbon Analyzer
Dataset-specific Description	DOC_uM and DOC_d13C_permille: For cruises PGC02-08 and Hydrates2004 samples were measured on an OI Analytical 1010 TOC analyzer with a nondispersive infrared detector interfaced to a ThermoFinnigan DELTAplus XP mass spectrometer.
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

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Deployments

PGC02-08

Website	https://www.bco-dmo.org/deployment/959799
Platform	CCGS John P. Tully
Start Date	2002-09-30
End Date	2002-10-14

Hydrates2004

Website	https://www.bco-dmo.org/deployment/959808
Platform	CCGS John P. Tully
Start Date	2004-06-21
End Date	2004-06-29

AT50-14

Website	https://www.bco-dmo.org/deployment/959811
Platform	R/V Atlantis
Start Date	2023-08-12
End Date	2023-08-20

AT50-29

Website	https://www.bco-dmo.org/deployment/959814
Platform	R/V Atlantis
Start Date	2024-08-08
End Date	2024-09-08
Description	AT50-29 is split up into 2 legs, described by OOI: AT50-29A & AT50-29B

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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/site/laphamhydrate/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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2049517

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