

Biogeochemical data on cryptic methane cycling in hypersaline sediments of the Carpinteria Salt Marsh Reserve, California

Website: <https://www.bco-dmo.org/dataset/839645>

Data Type: Other Field Results

Version: 1

Version Date: 2021-02-04

Project

» [Deciphering the Cryptic Cycling of Methane in Sediments of a Coastal Wetland](#) (Cryptic CH₄ Cycling)

| Contributors | Affiliation | Role |
|-----------------------------------|---|---------------------------|
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Abstract

Biogeochemical data on cryptic methane cycling in hypersaline sediments of the Carpinteria Salt Marsh Reserve, California. Sediments were collected in June 2018 from the hypersaline pool using large and small pushcores. Porewater was separated from sediment by centrifugation and subsampled for further analysis.

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Coverage

Spatial Extent: Lat:34.3989 Lon:-119.536

Temporal Extent: 2018-06-18

Methods & Sampling

Sediments were collected from the hypersaline pool within the Carpinteria Salt Marsh Reserve using large (20 cm i.d.) and small (2.6 cm i.d.) pushcores. Porewater was separated from sediment by centrifugation (4300 x g for 20 mins) and subsampled for further analysis described below.

Porewater sulfate and chloride concentrations were determined by ion chromatography (Metrohm 761). Porewater salinity was calculated from porewater chloride concentrations, using Knudsen's equation (Knudsen, 1901). Porewater sulfide and iron (II) concentrations were determined spectrophotometrically (Shimadzu UV-Spectrophotometer UV-1800) according to Cline, (1969) and Grasshoff et al., (1999) respectively. Porewater methane concentrations were determined by gas chromatography (Shimadzu GC-2014). Sediment porosity was determined by drying sediments at 75°C for five days and calculated using the difference between wet and dry weights, divided by the volume of sediment.

Sulfate reduction rates were determined by injecting carrier-free ³⁵S-Sulfate into intact whole round cores according to Jørgensen (1978); and incubated for 1 day. Sediment samples were then analyzed according to the cold-chromium distillation (Kallmeyer et al., 2004).

AOM rates were determined by injecting ¹⁴C-Methane dissolved in anoxic MilliQ into intact whole round cores similar to sulfate reduction rate determinations; and incubated for 1 day. Sediment samples were then analyzed according to Treude et al. (2005) and Joye et al. (2004).

Data Processing Description

Data Processing:

Excel was used for data processing.

BCO-DMO Processing:

- replaced "NA" with "nd" as missing data identifier;
- added ISO8601 UTC date/time column;
- renamed fields.

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Data Files

| File |
|--|
| biogeochemistry.csv (Comma Separated Values (.csv), 5.49 KB) MD5:428147d48a1a3cecb02056be12fc4d29 Primary data file for dataset ID 839645 |

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Related Publications

1901. Hydrographical tables according to the measurements of Carl Forch, J. P. Jacobsen, Martin Knudsen and S. P. L. Sijjrensen. G. E. C. Gad, Copenhagen (63 pp.). (Second edition 1931 fotoprinted by Tutein & Koch.)
Methods

Cline, J. D. (1969). Spectrophotometric Determination of Hydrogen Sulfide in Natural Waters. *Limnology and Oceanography*, 14(3), 454–458. doi:[10.4319/lm.1969.14.3.0454](https://doi.org/10.4319/lm.1969.14.3.0454)
Methods

Grasshoff, K., Kremling, K., & Ehrhardt, M. (Eds.). (1999). *Methods of Seawater Analysis*. doi:[10.1002/9783527613984](https://doi.org/10.1002/9783527613984)
Methods

Jorgensen, B. B. (1978). A comparison of methods for the quantification of bacterial sulfate reduction in coastal marine sediments. *Geomicrobiology Journal*, 1(1), 11–27. doi:[10.1080/01490457809377721](https://doi.org/10.1080/01490457809377721)
Methods

Joye, S. B., Boetius, A., Orcutt, B. N., Montoya, J. P., Schulz, H. N., Erickson, M. J., & Lugo, S. K. (2004). The anaerobic oxidation of methane and sulfate reduction in sediments from Gulf of Mexico cold seeps. *Chemical Geology*, 205(3-4), 219–238. doi:[10.1016/j.chemgeo.2003.12.019](https://doi.org/10.1016/j.chemgeo.2003.12.019)
Methods

Kallmeyer, J., Ferdelman, T. G., Weber, A., Fossing, H., & Jørgensen, B. B. (2004). A cold chromium distillation procedure for radiolabeled sulfide applied to sulfate reduction measurements. *Limnology and Oceanography: Methods*, 2(6), 171–180. doi:[10.4319/lom.2004.2.171](https://doi.org/10.4319/lom.2004.2.171)
Methods

Krause, S. J. E., & Treude, T. (2021). Deciphering cryptic methane cycling: Coupling of methylotrophic methanogenesis and anaerobic oxidation of methane in hypersaline coastal wetland sediment. *Geochimica et Cosmochimica Acta*, 302, 160–174. doi:[10.1016/j.gca.2021.03.021](https://doi.org/10.1016/j.gca.2021.03.021)
Results

Treude, T., Krüger, M., Boetius, A., & Jørgensen, B. B. (2005). Environmental control on anaerobic oxidation of methane in the gassy sediments of Eckernförde Bay (German Baltic). *Limnology and Oceanography*, 50(6),

1771-1786. doi:[10.4319/lo.2005.50.6.1771](https://doi.org/10.4319/lo.2005.50.6.1771)

Methods

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Parameters

| Parameter | Description | Units |
|-------------------------|--|--|
| Date | Date of sample collection; format: YYYY-MM-DD | unitless |
| Time_Local_PST | Time of sample collection (local time zone, PST); format: hh:mm:ss | unitless |
| Time_UTC | Time of sample collection (UTC); format: hh:mm:ss | unitless |
| Latitude | Latitude of sample collection | degrees North |
| Longitude | Longitude of sample collection | degrees East |
| Pushcore_Inner_Diameter | Inner diameter of pushcore | centimeters (cm) |
| Sediment_Depth | Sediment depth | centimeters (cm) |
| Porewater_Sulfate | Porewater Sulfate Concentration | millimolar (mM) |
| Salinity | Porewater Salinity Concentration | PSU |
| Porewater_Iron_II | Porewater Iron (II) Concentration | micromolar (uM) |
| Porewater_Sulfide | Porewater Sulfide Concentration | micromolar (uM) |
| Porosity | Sediment Porosity (v/v) | unitless |
| Sulfate_Reduction | Microbial Sulfate Reduction Rate | nanomoles per cubic centimeter per day (nmol cm-3 d-1) |
| Methane | Porewater Methane Concentration | micromolar (uM) |
| AOM | Microbial Anaerobic Oxidation of Methane (AOM) rate | nanomoles per cubic centimeter per day (nmol cm-3 d-1) |
| ISO_DateTime_UTC | Date and time of sample collection (UTC) formatted to ISO8601 standard: YYYY-MM-DDThh:mm:ssZ | unitless |

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Instruments

| | |
|---|---|
| Dataset-specific Instrument Name | centrifugation |
| Generic Instrument Name | Centrifuge |
| Generic Instrument Description | A machine with a rapidly rotating container that applies centrifugal force to its contents, typically to separate fluids of different densities (e.g., cream from milk) or liquids from solids. |

| | |
|---|--|
| Dataset-specific Instrument Name | Shimadzu GC-2014 |
| Generic Instrument Name | Gas Chromatograph |
| 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 | ion chromatography |
| Generic Instrument Name | Ion Chromatograph |
| 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 | Polycarbonate push cores large (20 cm I.d.) and small (2.6 cm I.d.) |
| Generic Instrument Name | Push Corer |
| Generic Instrument Description | Capable of being performed in numerous environments, push coring is just as it sounds. Push coring is simply pushing the core barrel (often an aluminum or polycarbonate tube) into the sediment by hand. A push core is useful in that it causes very little disturbance to the more delicate upper layers of a sub-aqueous sediment. Description obtained from: http://web.whoi.edu/coastal-group/about/how-we-work/field-methods/coring/ |

| | |
|---|--|
| Dataset-specific Instrument Name | Shimadzu UV-Spectrophotometer UV-1800 |
| Generic Instrument Name | UV Spectrophotometer-Shimadzu |
| Generic Instrument Description | The Shimadzu UV Spectrophotometer is manufactured by Shimadzu Scientific Instruments (ssi.shimadzu.com). Shimadzu manufactures several models of spectrophotometer; refer to dataset for make/model information. |

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Project Information

Deciphering the Cryptic Cycling of Methane in Sediments of a Coastal Wetland (Cryptic CH₄ Cycling)

Coverage: Carpinteria Salt Marsh Reserve, California, USA

NSF Award Abstract:

This research project investigates the close relationship between methane production and consumption in sediments by microbes in the oxygen-free zone of a coastal wetland in Southern California. The direct exchange of methane between those two closely related microbial groups, which has been named "cryptic methane cycling", has only recently been identified and little is known about its importance in reducing methane emissions from coastal wetlands. This research will reveal how carbon moves between the two types of microbes, and will identify the microbes involved. It will also reveal the important metabolic reactions responsible and the balance between methane production and consumption under different environmental conditions. Towards broader impacts, this project will provide training for two undergraduate and one graduate student in interdisciplinary wetland science and state of the art laboratory methods. A new freshmen course on global methane emissions will bring undergraduate students into the field to provide education on local coastal wetland environments. Results of the project will be disseminated to public and academic groups and will provide a better understanding of methane production and consumption in coastal wetlands.

Concentrations of atmospheric methane have more than doubled since the pre-industrial era, hence we urgently need to understand the mechanisms that control the emission of this potent greenhouse gas. Recent studies have provided the first evidence for the simultaneous microbial production and consumption of methane in the sulfate reduction zone of organic-rich sediments, a process named the "cryptic methane cycle." In this process, methane is proposed to be passed directly from methylotrophic methanogenesis to anaerobic oxidation of methane (AOM). However, little is known about the identity of the organisms involved, the trail of carbon from one metabolism to the other, or the environmental net result of the two processes. Without the details of this metabolic relationship, methane budgets of sediments remain incomplete. Coastal wetlands are of particular interest for the study of cryptic methane cycling, because their organic and sulfate rich sediments promote the production of methylated substrates for methylotrophic methanogenesis and provide electron acceptors for AOM. Yet, anaerobic microbial removal of methane from this ecosystem, particularly along the sulfate gradient between ocean and land, is still not well understood. Towards intellectual merit, this study elucidates the identity of methanogenic and methanotrophic archaea involved in cryptic methane cycling in a coastal wetland as well as the selection of electron acceptors that fuel methane removal in this metabolic relationship. The research provides new metabolic clues to unravel the versatility of the enzymatic machinery that drives methanogenesis and AOM. By capturing environmental factors that control the balance between the two processes working in close proximity, the results of this work further provide an enhanced understanding of methane dynamics in coastal wetland sediments. This information can be applied to biogeochemical models to improve the prediction of methane emissions from this ecosystem, which is found throughout the global coastal zone. Towards broader impacts, the research provides training in innovative analytical and experimental techniques to two undergraduate and one graduate student. The project further engages 20 undergraduates per year in a newly developed freshman seminar, "Methane - the Other Greenhouse Problem" including a field trip to the local wetland. The goal of the seminar will be to educate students, including those not entering STEM fields, about global sources and sinks of methane and its

involvement in global warming now and in the future. Results of this study will be broadly disseminated to educational and public outreach platforms, such as high schools, community colleges, and environmental non-profits to teach scientific methodologies, concepts of biogeochemical cycling, and enhance the appreciation of this vital coastal environment.

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 Earth Sciences (NSF EAR) | EAR-1852912 |

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