Porewater geochemical data from sediment pushcores collected from Southern California Seeps in July 2023 on R/V Atlantis cruise AT50-12

Website: https://www.bco-dmo.org/dataset/986669
Data Type: Cruise Results
Version: 1
Version Date: 2025-11-24

Project
» Collaborative Research: Redefining the footprint of deep ocean methane seepage for benthic ecosystems (Methanosphere)

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Abstract
This dataset provides geochemical data (major ions) for porewaters from sediment pushcores collected by DSV Alvin from the R/V Atlantis in July 2023 (AT50-12) at methane seeps in the Southern California Borderlands, California, USA. Cores were sectioned into 1-3 centimeter (cm) horizons, and porewater was extracted shipboard using an argon-pressurized squeezer. Porewater samples were frozen at sea and thawed just before analysis. We report concentrations of fluoride, acetate, formate, chloride, bromide, nitrate, sulfate, thiosulfate, and phosphate anions and lithium, sodium, potassium, magnesium, and calcium cations. Measurements were made using the Thermo Dual Dionex Integrion HPIC ion chromatography system with either a 250 millimeter (mm) Dionex IonPac AS19-4 micrometer (um) column (anions) or a 250 mm Dionex IonPac CS16-4um column (cations), in the Resnick Water and Environment Laboratory at the California Institute of Technology (Caltech).

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Coverage

Location: Southern California Borderlands, Pacific Ocean
Spatial Extent: **N**:33.79968797 **E**:-117.40811 **S**:32.813523 **W**:-118.6471938
Temporal Extent: 2023-07-16 - 2023-07-27

Methods & Sampling

Sediment pushcores were collected by deep-submergence vehicle (DSV) Alvin from the R/V Atlantis in July 2023 (cruise ID AT50-12) at La Jolla Reef (32.8135, -117.4081), Del Mar Seep (32.9043, -117.7824), Santa Monica

Seep Mound 800 (33.7993, -118.6465), Santa Monica Seep Mound 863 (33.7891, -118.6683), Qupé Seep (Redondo Knoll) (33.6505, -118.5522), and Palos Verdes Seep (33.6993, -118.3766). Pushcores were manually sectioned into 1 or 3 centimeter (cm) horizons using plastic rings, and porewaters were extracted using a KC Denmark squeezer. Samples for ion chromatography were frozen shipboard and thawed immediately prior to analysis. Measurements were made using a Thermo Dual Dionex Integrion HPIC ion chromatography system with either a 250 millimeter (mm) Dionex IonPac AS19-4 micrometer (um) column (anions) with 50 mm guard column or a 250 mm Dionex IonPac CS16-4um column (cations) with a 50 mm guard column, in the Resnick Water and Environment Laboratory at the California Institute of Technology (Caltech).

Data Processing Description

100 microliter (uL) samples are diluted 50x in milliQ nanopure water before running. Standard curves are generated using calibration standards diluted similarly to samples, with 100 uL of 500 millimolar (mM) NaCl added to mimic typical seawater sample peak behavior. Analyte peaks are integrated and values are calculated using the standards automatically in the Chromeleon software, with manual QC to ensure regular peak shapes.

BCO-DMO Processing Description

- Imported original file "AT50-12_IC_all_forsubmission_20250414.csv" into the BCO-DMO system.
- Marked "n.a.", "NOT MEASURED", and "NOT_MEASURED" as missing data values (missing data are empty/blank in the final CSV file).
- Replaced non-standard character "é" with "e" in the "Station" column.
- Converted "Date_UTC" column to YYYY-MM-DD format.
- Removed the empty "NOT_MEASURED" column.
- Saved the final file as "986669_v1_at50-12_ic_data.csv".

Problem Description

Na and Cl are not quantitative, as the standards have an excess of each spiked in, above the upper limit of quantification. Formate values reported as ND indicate they are below the LoQ but not LoD. Ca elutes near the end of the run, and occasionally is not captured in its entirety. Other values noted as ND were below the quantifiable detection limit, or not detected. The limits of detection for each ion are lithium 22 uM, ammonium 194 uM, potassium 566 uM, magnesium 1.6 mM, calcium 198 uM, formate 15 uM, acetate 21 uM, fluoride 23 uM, bromide 40 uM, nitrate 114 uM, sulfate 561 uM, thiosulfate 25 uM, phosphate 47 uM.

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Parameters

Parameter	Description	Units
serial	Internal Orphan Lab identifier (sample serial number)	unitless
Fluoride	concentration of fluoride ion	millimolar (mM)
Acetate	concentration of acetate ion	millimolar (mM)
Formate	concentration of formate ion	millimolar (mM)

Chloride	concentration of chloride ion	millimolar (mM)
Bromide	concentration of bromide ion	millimolar (mM)
Nitrate	concentration of nitrate ion	millimolar (mM)
Sulfate	concentration of sulfate ion	millimolar (mM)
Thiosulfate	concentration of thiosulfate ion	millimolar (mM)
Phosphate	concentration of phosphate ion	millimolar (mM)
Lithium	concentration of lithium ion	millimolar (mM)
Sodium	concentration of sodium ion	millimolar (mM)
Ammonium	concentration of ammonium ion	millimolar (mM)
Potassium	concentration of potassium ion	millimolar (mM)
Magnesium	concentration of magnesium ion	millimolar (mM)
Calcium	concentration of calcium ion	millimolar (mM)
pH	pH value, measured shipboard	unitless
Dive	Dive Number, DSV Alvin	unitless
Lat	Latitude	decimal degrees
Long	Longitude	decimal degrees
Horizon	Depth (cm) in sediment, measured from top of core	centimeters (cm)
Date_UTC	Core collection date (UTC)	unitless
Time_UTC	Core collection time (UTC)	unitless

Depth_m	ocean depth in meters at the sampling location	meters (m)
Station	name of the sampling site	unitless
Sample_Name	the sample name, which is composed of the dive number and the DSV pushcore number	unitless

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Instruments

Dataset-specific Instrument Name	DSV Alvin
Generic Instrument Name	HOV Alvin
Dataset-specific Description	DSV Alvin is owned by the U. S. Navy and operated for NSF by the Woods Hole Oceanographic Institution (WHOI). DSV Alvin is capable of diving to 6500 meters (about 4 miles). The R/V Atlantis is the support vessel for Alvin. For a complete description see: https://www.whoi.edu/what-we-do/explore/underwater-vehicles/hov-alvin/
Generic Instrument Description	Human Occupied Vehicle (HOV) Alvin is part of the National Deep Submergence Facility (NDSF). Alvin enables in-situ data collection and observation by two scientists to depths reaching 6,500 meters, during dives lasting up to ten hours. Commissioned in 1964 as one of the world's first deep-ocean submersibles, Alvin has remained state-of-the-art as a result of numerous overhauls and upgrades made over its lifetime. The most recent upgrades, begun in 2011 and completed in 2021, saw the installation of a new, larger personnel sphere with a more ergonomic interior; improved visibility and overlapping fields of view; longer bottoms times; new lighting and high-definition imaging systems; improved sensors, data acquisition and download speed. It also doubled the science basket payload, and improved the command-and-control system allowing greater speed, range and maneuverability. With seven reversible thrusters, it can hover in the water, maneuver over rugged topography, or rest on the sea floor. It can collect data throughout the water column, produce a variety of maps and perform photographic surveys. Alvin also has two robotic arms that can manipulate instruments, obtain samples, and its basket can be reconfigured daily based on the needs of the upcoming dive. Alvin's depth rating of 6,500m gives researchers in-person access to 99% of the ocean floor. Alvin is a proven and reliable platform capable of diving for up to 30 days in a row before requiring a single scheduled maintenance day. Recent collaborations with autonomous vehicles such as Sentry have proven extremely beneficial, allowing PIs to visit promising sites to collect samples and data in person within hours of their being discovered, and UNOLs driven technological advances have improved the ability for scientific outreach and collaboration via telepresence Alvin is named for Allyn Vine, a WHOI engineer and geophysicist who helped pioneer deep submergence research and technology. (from https://www.whoi.edu/what-we-do/explore/underwater-vehicles/hov-alvin/, accessed 2022-09-09)

Dataset-specific Instrument Name	Thermo Dual Dionex Integrion HPIC ion chromatography system
Generic Instrument Name	Ion Chromatograph
Dataset-specific Description	Thermo Dual Dionex Integrion HPIC ion chromatography system with either a 250 mm Dionex IonPac AS19-4um column (anions) with 50 mm guard column or a 250 mm Dionex IonPac CS16-4um column (cations) with a 50 mm guard column, in the Resnick Water and Environment Laboratory at the California Institute of Technology (Caltech).
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	KC Denmark squeezer
Generic Instrument Name	KC Pore-Water Pressing Bench
Dataset-specific Description	Porewaters were extracted using a KC Denmark squeezer.
Generic Instrument Description	The KC Pore-water pressing bench, made by KC Denmark Research Equipment, allows pore-water extraction of any kind of sediments, from sediments rich in organic material, to sandy sediments. Sediment cores are segmented and placed in the pressing house, which is closed by means of the handle on top of the house. An over-pressure is applied (fed-in) at the reduction valve and the valves of the houses in operation are opened. The resulting compression of the sediment matrix leads to expelling of the pore-water, which is sampled in containers beneath the pressing house. Operation in a glove bag prevents atmospheric contamination with, for example, oxygen, so anaerobic analysis of the pore-water is possible. The standard cylinders are made from black Polyoxymethylene (POM). However, the cylinders and all accessories are also available as AISI 316 stainless steel for special purposes. The pressing bench consists of 5 pressing houses, each 100 ml. They can hold a maximum sample diameter of 40 mm. The instrument has a maximum operating pressure of 4 bar (400 kPa).

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Deployments

AT50-12

Website	https://www.bco-dmo.org/deployment/946261
Platform	R/V Atlantis
Start Date	2023-07-16
End Date	2023-07-29
Description	See more information in R2R: https://www.rvdata.us/search/cruise/AT50-12

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Project Information

Collaborative Research: Redefining the footprint of deep ocean methane seepage for benthic ecosystems (Methanosphere)

Coverage: Gulf of Alaska and Southern California Bight

NSF Award Abstract:
This research examines the role of deep-sea organisms in determining the fate and footprint of methane, a potent greenhouse gas, on Pacific continental margins. The investigators are evaluating the deep ocean methanosphere defined by the microbial communities that consume methane and the animals that directly feed on or form symbioses with methane-consuming microbes. They are also investigating animal communities that gain energy indirectly from methane, as well as those that take advantage of carbonate rocks, the physical manifestation of methane consumption in seafloor sediments. The study of methane seeps in the deep waters of both Alaska (4400-5500 meters) and Southern California (450-1040 meters) is enabling comparisons of the methanosphere under different food-limitation and oxygen regimes. By applying diverse chemical, isotopic, microscopy, and genetic-based analyses to seep microbes and fauna, this study is advancing understanding of the contribution of methane to deep-sea biodiversity and ecosystem function, information that can inform management and conservation actions in US waters. In addition to training for graduate and undergraduate students at their home institutions, the investigators are collaborating with the Alaska Native Science and Engineering Program (ANSEP). They are recruiting Alaskan undergraduates to participate in the research, contributing to ANSEP's online resources that promote interaction between scientists and middle and high school students, and participating in ANSEP's annual residential Career Exploration in Marine Science programs to engage middle school students in learning about deep-sea ecosystems and the variety of career pathways available in marine related fields.

Microbial production and consumption of methane is dynamic and widespread along continental margins, and some animals within deep-sea methane seeps rely on the oxidation and sequestration of methane for nutrition. At the same time, understanding of methane-dependent processes and symbioses in the deep-sea environment is still rudimentary. The goals of this study are to 1) examine the diversity of animals involved in methane-based symbioses and heterotrophic consumption of methane-oxidizing microbes and how these symbioses extend the periphery of seeps, contributing to non-seep, continental slope food webs; and 2) determine whether carbonates on the seep periphery sustain active methanotrophic microbial assemblages, providing a localized food source or chemical fuel for thiotrophic symbioses, via anaerobic oxidation of methane, or free-living, sulfide-oxidizing bacteria consumed by animals. The investigators are addressing these goals by surveying, sampling, and characterizing microbes, water, sediments, carbonates and animals at a deep seep site on the Aleutian Margin and a shallow site off Southern California. Shipboard experiments and laboratory analyses are using molecular, isotopic, geochemical, and radiotracer tools to understand transfer of methane-sourced carbon from aerobic methanotrophs under multiple oxygen levels, pressures, and photosynthetic food inputs. This approach offers a wide lens by which to examine the methane seep footprint, allow reinterpretation of past observations, and identify new scientific areas for future study. Improved characterization of the deep continental margin methanosphere informs climate science, biodiversity conservation, and resource management.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2048666

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