Isotopes in methane in natural waters of Alaska

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Project
» EAGER: Subterranean Ground Water Discharge (SGD) in the Arctic as a Source of Atmospheric Methane? A Proof of Concept Study (Groundwater Discharge Methane)

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Dataset Description

C-13 and H-2 in methane, and methane concentration in ground, lake, river, and coastal ocean water of Alaska

Methods & Sampling

Sampling and Analytical Methodology:
Discrete groundwater, lake, and river water samples were collected from Toolik Lake in September 2013 and July 2014. Groundwater samples were collected in all locations from freshly dug pits or temporary PVC well points of variable depth depending on the depth of the water table. All water samples were collected by submersible pump. Sample collection followed previously established methods into glass wheaton bottles, as did measurement of methane concentration. Dissolved CH_4 concentrations in water samples were measured using a headspace equilibration technique. Water samples were collected by direct filling of 125 mL or 160 mL glass serum bottles. The serum bottles were sealed without headspace using blue butyl stoppers, and saturated $HgCl_2$ solution (0.3 mL) was added immediately after sample collection to halt biological activity. Before analysis, 10 % of total water sample volume was removed; replaced by the same volume of helium gas as the headspace. Sample vials were shaken vigorously for 3 minutes and placed on a shaker for 30 min at room temperature (25 ºC).

CH_4 concentrations for all samples were measured on an SRI 310 Gas Chromatograph (GC) equipped with a flame ionization detector and an Alltech Haysep S 100/120 column (6' x 1/8" x 0.085"). 0.25 mL of gas was removed from the headspace with a syringe for analysis, and the same volume of Milli-Q water was injected to replace the volume of the gas removed. Helium was used as the carrier gas at a flow rate of 15 mL min^{-1}, and the column and detector temperatures were maintained at 50 °C and 150 °C, respectively. Peak integration was performed using Peak Simple NT software. Gas mixtures used for GC calibration and standard curves

were made using successive dilutions of 1000 ppm CH_4. Total [CH_4] in the water samples was calculated by adding the measured headspace [CH_4] and the amount of CH_4 remaining in the water sample after headspace equilibration, calculated from the solubility equation of (Yamamoto et al. 1976). The average combined standard error of sampling and analysis was 3.6 % (n= 27). After methane concentration analysis, the remaining headspace gas samples were split into two 10-mL exetainers for δ^{13}C-CH_4 and δD-CH_4 analysis. δD-CH_4 was analyzed at the UC Davis Stable Isotope Facility on a ThermoScientific PreCon concentration system interfaced to a ThermoScientific Delta V Plus isotope ratio mass spectrometer (ThermoScientific, Bremen, DE). δ^{13}C-CH_4 was analyzed at the Lawrence Livermore National Laboratory using the standard TraceGas preconcentration system interfaced with an IsoPrime isotope ratio mass spectrometer (IsoPrime Ltd, UK) as described by Fisher et al. (2006). The mass requirements for δ^{13}C-CH_4 and for δD-CH_4 analyses was 10 nmoles and 2 nmoles respectively.

Data Processing Description

BCO-DMO Processing Notes
- Generated from original file "AK discrete methane concetration and isotopes.xlsx" contributed by Alanna Lecher
- Parameter names edited to conform to BCO-DMO naming convention found at Choosing Parameter Name
- Longitude values converted to negative for West Longitude
- "nd" (no data) inserted into blank cells
- "NA" replaced with "nd" (no data)
- Date reformatted to YYYYMMDD

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Data Files

File
Isotopes_Methane.csv (Comma Separated Values (.csv), 7.13 KB) MD5:75cb93dcf94d5718efeece66705389d8
Primary data file for dataset ID 642404

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Related Publications

Garcia-Solsona, E., Garcia-Orellana, J., Masqué, P., & Dulaiova, H. (2008). Uncertainties associated with 223Ra and 224Ra measurements in water via a Delayed Coincidence Counter (RaDeCC). Marine Chemistry, 109(3-4), 198–219. doi:10.1016/j.marchem.2007.11.006
General

Moore, W. S. (2008). Fifteen years experience in measuring 224Ra and 223Ra by delayed-coincidence counting. Marine Chemistry, 109(3-4), 188–197. doi:10.1016/j.marchem.2007.06.015
General

Moore, W. S., & Arnold, R. (1996). Measurement of 223Ra and224Ra in coastal waters using a delayed coincidence counter. Journal of Geophysical Research: Oceans, 101(C1), 1321–1329. doi:10.1029/95jc03139 https://doi.org/10.1029/95JC03139
General

Young, M. B., Gonneea, M. E., Fong, D. A., Moore, W. S., Herrera-Silveira, J., & Paytan, A. (2008). Characterizing sources of groundwater to a tropical coastal lagoon in a karstic area using radium isotopes and water chemistry. Marine Chemistry, 109(3-4), 377–394. doi:10.1016/j.marchem.2007.07.010
General

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Parameters

Parameter	Description	Units
Sample_ID	Sample_ID	text
Date	Date	YYYYMMDD
Latitude	Latitude (South is negative)	decimal degrees
Longitude	Longitude (West is negative)	decimal degrees
sample_type	sample_type	text
sample_depth	sample_depth	meters
Temp	Temperature	deg C
CH4	CH4	nM
d2H_CH4	d2H_CH4	‰
d13C_CH4	d13C_CH4	‰

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Instruments

Dataset-specific Instrument Name	glass wheaton bottles
Generic Instrument Name	Bottle
Dataset-specific Description	Sample collection followed previously established methods into glass wheaton bottles, as did measurement of methane concentration.
Generic Instrument Description	A container, typically made of glass or plastic and with a narrow neck, used for storing drinks or other liquids.

Dataset-specific Instrument Name	ThermoScientific PreCon concentration system
Generic Instrument Name	Gas Analyzer
Dataset-specific Description	δD-CH4 was analyzed at the UC Davis Stable Isotope Facility on a ThermoScientific PreCon concentration system interfaced to a ThermoScientific Delta V Plus isotope ratio mass spectrometer (ThermoScientific, Bremen, DE). δ13C-CH4 was analyzed at the Lawrence Livermore National Laboratory using the standard TraceGas preconcentration system interfaced with an IsoPrime isotope ratio mass spectrometer (IsoPrime Ltd, UK) as described by Fisher et al. (2006). The mass requirements for δ13C-CH4 and for δD-CH4 analyses was 10 nmoles and 2 nmoles respectively.
Generic Instrument Description	Gas Analyzers - Instruments for determining the qualitative and quantitative composition of gas mixtures.

Dataset-specific Instrument Name	SRI 310 Gas Chromatograph (GC)
Generic Instrument Name	Gas Chromatograph
Dataset-specific Description	CH4 concentrations for all samples were measured on an SRI 310 Gas Chromatograph (GC) equipped with a flame ionization detector and an Alltech Haysep S 100/120 column (6’ x 1/8” x 0.085”).
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	ThermoScientific Delta V Plus isotope ratio mass spectrometer
Generic Instrument Name	Mass Spectrometer
Dataset-specific Description	After methane concentration analysis, the remaining headspace gas samples were split into two 10-mL exetainers for δ13C-CH4 and δD-CH4 analysis. δD-CH4 was analyzed at the UC Davis Stable Isotope Facility on a ThermoScientific PreCon concentration system interfaced to a ThermoScientific Delta V Plus isotope ratio mass spectrometer (ThermoScientific, Bremen, DE). δ13C-CH4 was analyzed at the Lawrence Livermore National Laboratory using the standard TraceGas preconcentration system interfaced with an IsoPrime isotope ratio mass spectrometer (IsoPrime Ltd, UK) as described by Fisher et al. (2006). The mass requirements for δ13C-CH4 and for δD-CH4 analyses was 10 nmoles and 2 nmoles respectively.
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	IsoPrime isotope ratio mass spectrometer
Generic Instrument Name	Mass Spectrometer
Dataset-specific Description	After methane concentration analysis, the remaining headspace gas samples were split into two 10-mL exetainers for δ13C-CH4 and δD-CH4 analysis. δD-CH4 was analyzed at the UC Davis Stable Isotope Facility on a ThermoScientific PreCon concentration system interfaced to a ThermoScientific Delta V Plus isotope ratio mass spectrometer (ThermoScientific, Bremen, DE). δ13C-CH4 was analyzed at the Lawrence Livermore National Laboratory using the standard TraceGas preconcentration system interfaced with an IsoPrime isotope ratio mass spectrometer (IsoPrime Ltd, UK) as described by Fisher et al. (2006). The mass requirements for δ13C-CH4 and for δD-CH4 analyses was 10 nmoles and 2 nmoles respectively.
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	Submersible Pump
Generic Instrument Name	Pump
Dataset-specific Description	Discrete seawater, groundwater, lake, and river water samples were collected from Kasitsna Bay and Toolik Lake in August 2011 and July 2012 and the Beaufort Sea August 2012. Groundwater samples were collected in all locations from freshly dug pits or temporary PVC well points of variable depth depending on the depth of the water table. All water samples were collected by submersible pump. Sample water was passed through a plastic column containing manganese dioxide impregnated acrylic fiber at a rate of
Generic Instrument Description	A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps

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Deployments

ALASKA_Paytan_Methane_2013-2014

Website	https://www.bco-dmo.org/deployment/642515
Platform	shoreside ALASKA_Paytan
Start Date	2013-09-13
End Date	2014-07-07
Description	Discrete groundwater, lake, and river water samples were collected from Toolik Lake in September 2013 and July 2014.

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Project Information

EAGER: Subterranean Ground Water Discharge (SGD) in the Arctic as a Source of Atmospheric Methane? A Proof of Concept Study (Groundwater Discharge Methane)

Coverage: Alaskan Pacific and Arctic Coastline, and Toolik Lake on the North Slope of Alaska

Extracted from the NSF award abstract:
The major objective of this proof of concept study is to evaluate the contribution of Subterranean Groundwater Discharge (SGD) in the Arctic to the global methane budget. Methane is a potent greenhouse gas and large natural reservoirs exist in Arctic soils and permafrost. The working hypothesis is that methane released from thawing permafrost in the Arctic is transported via groundwater flow (above and below the permafrost layer) and enters the atmosphere via coastal waters and lakes. This source of methane may be realized as an important source of natural methane to the atmosphere and may provide a positive feedback to global warming.

The objectives of the study are:

1) To estimate the magnitude of subterranean groundwater discharge and associated methane flux into lakes and coastal waters in Alaska at three representative sites.

2) To evaluate methane evasion rates from the water column to the atmosphere.

3) To determine if the contribution of methane input from subterranean groundwater discharge to the global methane budget is significant, and if so

4) To use the preliminary data to design a more through research plan that will enable precise estimates of fluxes and provide a basis for global extrapolation of results such that the contribution of this source to current and future climate changes and the global methane budget will be possible.

The project will support a graduate student full time for two years. Undergraduate students in the ACCESS program and the California Alliance for Minority Participation in Science, Engineering and Mathematics program at UCSC will also participate in the proposed work. The PIs will work with COSEE Alaska to ntegrate this work in their outreach and education activities including teacher workshops, symposia, and work with local communities in Alaska.

PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH
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Ms. Alanna Lecher , Dr. Natasha Dimova , Ms. Katy Sparrow , Dr. Fenix Garcia-Tigreros , Mr. Joseph Murray , Dr. Slawek Tulaczyk , Dr. John Kessler. "Groundwater Discharge a Conduit for Methane Emissions in the Arctic," *Nature Geoscience*, 2015.

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Funding

Funding Source	Award
NSF Division of Polar Programs (NSF PLR)	PLR-1114485

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