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Source characterization and temporal variation of methane seepage from thermokarst lakes on the Alaska North Slope in response to Arctic climate change

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Source characterization and temporal variation of methane seepage from thermokarst lakes on the Alaska North Slope in response to arctic climate change

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QUARTERLY PROGRESS REPORT
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Summary

The goals of this research are to characterize the source, magnitude and temporal variability of methane seepage from two representative thermokarst lake areas within the Alaskan North Slope gas hydrate province, assess the vulnerability of these areas to ongoing and future Arctic climate change and determine if gas hydrate dissociation resulting from permafrost melting is contributing to the current lake emissions.

Work during the third quarter of this project has focused on conducting the group's first field work in the spring of 2009 (May 2009) and planning for the group's summer field work (July 7th – 18th). The majority of the project's future tasks are contingent on the acquisition of samples to analyze from the proposed field locations. These future tasks will be initiated once samples have been collected from the proposed field sites.

Activities in This Reporting Period

Task 2.0 - Continuous Literature Research and Updating

The Recipient has updated a pdf reference library of related and relevant literature using the program "Papers" (see http://mekentosj.com/papers/). The USGS is continuing to compile hard-to-obtain North Slope reports from its own national libraries and working on the transfer of a North Slope gas chemistry database from the Central/Western Regions to the Woods Hole office.

Task 3.0 – Develop Data Collection and Sampling Plan

The UAF/USGS team developed a data collection and sampling plan to cover field activities occurring in year 1. The final plan was submitted 20 days prior to the field work (commencing May 7th 2009).

Status summary of other project related activities that have taken place during the last quarter:

1) The group has fully planned and managed its own logistics for the July field work.
2) Preparations for Task 11.0: Methane oxidation in Alaskan thermokarst lakes. Dr. He accompanied the group during its May field work. She was able to take samples specifically for this task with the support of Dr. Mary Beth Leigh and the rest of the field group.
3) Task 4.0 – Field-work in Alaska (Year 1) (See details below).
4) A project website has been established documenting a pilot field study related to research at Qalluuraq Lake: (http://www.uaf.edu/water/ASIF/Methane%20ecology/Front%20page.html). The website was updated in June 2009 with descriptions of the May 2009 field work on the North Slope and Fairbanks area in Alaska: (http://www.uaf.edu/water/ASIF/Methane%20ecology/Field%20work%20May%2009.html).

May 2009 field work:

Fieldwork took place within this quarter between May 7th – 14th 2009.

1) A list of objectives

The primary objective of the May 2009 fieldwork was to acquire the samples needed to conduct Tasks 5-8 during Phase II of the project. These include acquisition of sample of lake sediment for studying past methane emissions (Task 8), to conduct stable isotope probing (Task 7) and gas analyses and flux measurements (Task 5). In addition the fieldwork was to support the collection of water samples for Monica Heintz to conduct methane oxidation rate measurements at Kilarney and Lake Qalluuraq.

All of the objectives were successfully achieved. Cores of lake sediment were collected for studying past methane emissions (Task 8), to conduct stable isotope probing (Task 7) and to conduct gas analyses (Task 5). Water samples were collected for Monica Heintz to conduct methane oxidation rate measurements at Kilarney and Lake Qalluuraq. Additional cores were collected from two lakes adjacent to Lake Qalluuraq and from a second lake in the Fairbanks area (Goldstream Bill Lake).

2) A list of data collected from the field site

A total of 23 cores of sediment were collected from Lake Qalluuraq, Kilarney Lake and Lake Goldstream Bill (Table 1). The majority of the cores were taken from Lake Qalluuraq, the locations of which are shown in Figure 1. GPS coordinates were taken at each location. The cores ranged in length from ~50 cm to 2.5m and are to be dedicated to sample analyses related to future project tasks (e.g. Task 7 and 8). Oxidation and reduction potential (ORP) measurements were conducted on the majority of the Biogeochem cores and magnetic susceptibility measurements were made on the majority of the Paleo cores (Table 2). Limnological characteristics were measured at Lake Qalluuraq, Terrapin Lake and Coffee Lake by Pohlman and Walter (Table 3). Benthic invertebrates (chironomids) were collected from the sites for isotopic analyses (Wooller).

3) A list of samples collected from the field site

A total of 23 cores of sediment were collected from Lake Qalluuraq, Kilarney Lake and Lake Goldstream Bill (Table 1). All of the Biogeochem cores were subsampled during the field work for Biogeochemical analyses (Leigh, He and Pohlman) and pore water chemistry (Pohlman). Water samples were collected from the locations without grounded ice (Figure 1) for methane oxidation rate measurements and DNA analyses (Heintz). Gas samples were taken from the seep location for analysis (Walter) and noble gas analysis (Pohlman). Water was collected from the site locations with water present for oxygen and hydrogen isotope analyses, POC (particulate organic carbon) stable isotopes (C and N), DIC (dissolved inorganic carbon) stable isotopes (C and O). Photos and videos were taken throughout the fieldwork and will feature on new pages of the groups website.

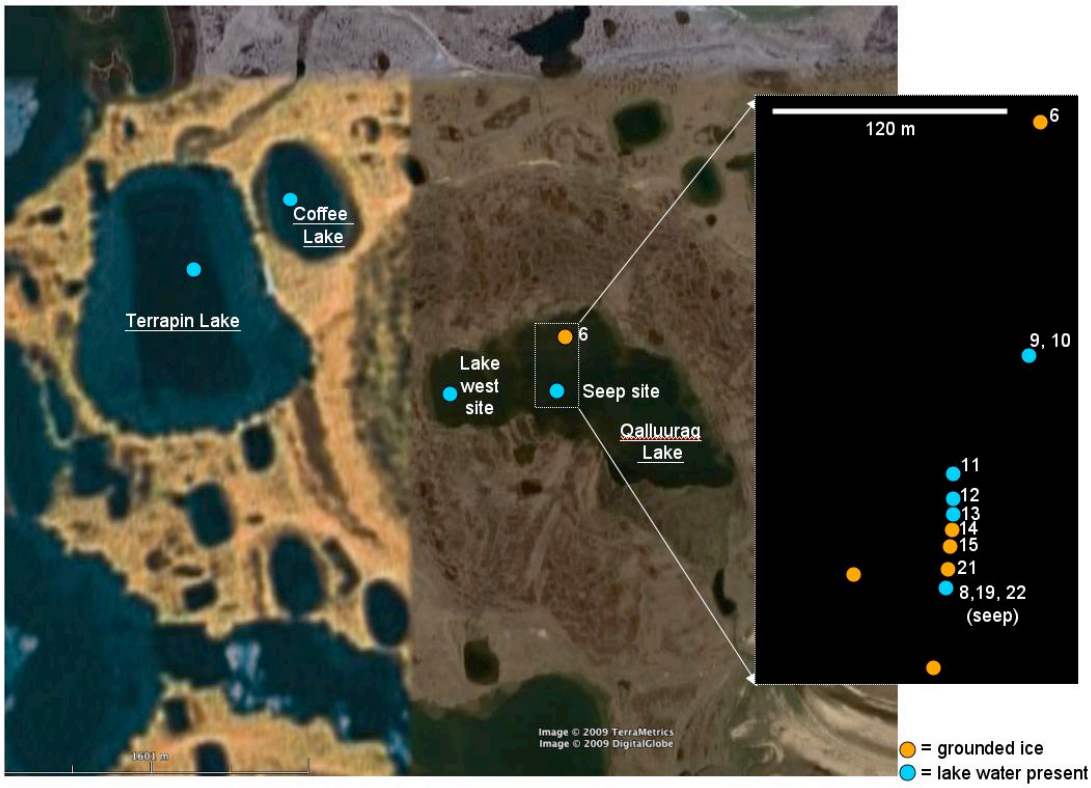

Figure 1: Map of locations in Lake Qalluuraq.

Table 1: Cores collected during the May fieldwork.

Core Code	Purpose	General Site location	Lake
LKA509	Archive (material in reserve)	Lake Kilarney, Fairbanks area	Kilarney
LKB509a	Biogeochem (Task 7)	Lake Kilarney, Fairbanks area	Kilarney
LKB509a	Biogeochem (Task 7)	Lake Kilarney, Fairbanks area	Kilarney
LKC509	Paleo (option for Task 8)	Lake Kilarney, Fairbanks area	Kilarney
GB509*	Biogeochem (Task 7)*	Goldstream Bill Lake, Fairbanks area	Goldstream Bill
LQSLA509	Archive (material in reserve)	North slope, at methane seep (GPS # 8)	Qalluuraq
LQSLB509a	Biogeochem (Task 7)	North slope, at methane seep (GPS # 8)	Qalluuraq
LQSLB509b	Biogeochem (Task 7)	North slope, at methane seep (GPS # 8)	Qalluuraq
LQSLC509a	Paleo (option for Task 8)	North slope, at methane seep (GPS # 8)	Qalluuraq
LQSLC509b	Paleo (option for Task 8)	North slope, at methane seep (GPS # 8)	Qalluuraq
LQSSA509	Archive (material in reserve)	North slope, away from methane seep (GPS # 22 inside grounded ice)	Qalluuraq
LQSSB509	Biogeochem (Task 7)	North slope, away from methane seep (GPS # 22 inside grounded ice)	Qalluuraq
LQSSC509	Paleo (option for Task 8)	North slope, away from methane seep (GPS # 22 inside grounded ice)	Qalluuraq
LQSSA509b	Paleo (option for Task 8)	North slope, away from methane seep (GPS # 13 outside grounded ice)	Qalluuraq
LQSSB509b	Biogeochem (Task 7)	North slope, away from methane seep (GPS # 13 outside grounded ice)	Qalluuraq
LQASA509	Archive (material in reserve)	North slope, further from methane seep (GPS # 9)	Qalluuraq
LQASB509a	Biogeochem (Task 7)	North slope, further from methane seep (GPS # 9)	Qalluuraq
LQASB509b	Biogeochem (Task 7)	North slope, further from methane seep (GPS # 9)	Qalluuraq
LQASC509a	Paleo (option for Task 8)	North slope, further from methane seep (GPS # 9)	Qalluuraq
LQASC509b	Paleo (option for Task 8)	North slope, further from methane seep (GPS # 9)	Qalluuraq
LQW509	Paleo (option for Task 8)	North slope, Lake Qalluuraq West Site	Qalluuraq
Coffee Lake*	Core available for further analyses of non seep site*	North slope, Lake adjacent to Lake Qalluuraq	Coffee Lake
Terrapin Lake*	Core available for further analyses of non seep site*	North slope, Lake adjacent to Lake Qalluuraq	Terrapin Lake

* Samples taken as a resource for additional analyses if further funding allows.

Table 2: Cores collected during the May fieldwork and magnetics and ORP data available.

Core Code	Purpose	Lake	Magnetics data	ORP data
LKA509	Archive (material in reserve)	Kilarney		X
LKB509a	Biogeochem (Task 7)	Kilarney		
LKB509a	Biogeochem (Task 7)	Kilarney		
LKC509	Paleo (option for Task 8)	Kilarney	X	
GB509*	Biogeochem (Task 7)*	Goldstream Bill		
LQSLA509	Archive (material in reserve)	Qalluuraq	X	
LQSLB509a	Biogeochem (Task 7)	Qalluuraq		
LQSLB509b	Biogeochem (Task 7)	Qalluuraq		X
LQSLC509a	Paleo (option for Task 8)	Qalluuraq	X	
LQSLC509b	Paleo (option for Task 8)	Qalluuraq	X	
LQSSA509	Archive (material in reserve)	Qalluuraq		
LQSSB509	Biogeochem (Task 7)	Qalluuraq		X
LQSSC509	Paleo (option for Task 8)	Qalluuraq	X	
LQSSA509b	Paleo (option for Task 8)	Qalluuraq	X	
LQSSB509b	Biogeochem (Task 7)	Qalluuraq		X
LQASA509	Archive (material in reserve)	Qalluuraq	X	
LQASB509a	Biogeochem (Task 7)	Qalluuraq		X
LQASB509b	Biogeochem (Task 7)	Qalluuraq		X
LQASC509a	Paleo (option for Task 8)	Qalluuraq	X	
LQASC509b	Paleo (option for Task 8)	Qalluuraq	X	
LQW509	Paleo (option for Task 8)	Qalluuraq	X	
Coffee Lake*	Core available for further analyses of non seep site*	Coffee Lake	X	
Terrapin Lake*	Core available for further analyses of non seep site*	Terrapin Lake	X	

Table 3: Limnological characteristics.

Lake	Depth (m)	Temp deg C	SpCond µS/cm	Sal ppt	pH Units	ORP mV	LDO (%) Sat	LDO mg/L	TDS g/L	CHL µg/l	TurbSC NTU
Lake Q, main seep	0.1	0.05	188	0.09	5.8	193	0.8	0.09	0.1	2.2	18.2
Lake Q, main seep	1	0.02	188	0.08	5.83	191	0.7	0.09	0.1	2.19	18.5
Lake Q, main seep	1.75	0.01	188	0.09	5.88	192	0.6	0.07	0.1	2.19	19.5
Lake Q, GPS22	0.1	0.18	111	0.04	6.06	227	83.4	10.02	0.1	2.7	21.6
Lake Q, GPS22	1	0.01	181	0.08	5.93	220	12.8	1.52	0.1	2.18	18.3
Lake Q, GPS22	1	0.13	189	0.09	5.98	212	2.8	0.34	0.1	2.28	17.2
Lake Q, GPS13	1.3	-0.17	94	0.1	5.75	308	89.7	11.05	0.1	7.9	140
Lake Q, GPS9	1	0.03	70	0.02	5.57	348	80.4	9.83	0	32.25	4.3
Lake Q, GPS9	1.7	0.48	139	0.06	5.89	272	1.5	0.18	0.1	29.2	14.6
Coffee Lake	1.5	-0.04	209	0.1	6.17	302	10	2.33	0.1	1.38	9.6
Terrapin Lake	1.75	1.01	160	0.07	6.05	313	7	0.83	0.1	1.23	7.9
Terrapin Lake	2.25	1.63	172	0.08	6	303	4.1	0.48	0.1	2.1	9.1

Milestones log - indicate status of milestones.

Preparations are continuing for the group's summer field-work (July 2009: Qalluuraq Lake seep and Kilarney Lake). Field equipment, which includes coring and seismic imaging equipment, is being organized. Dates are agreed for summer 2009 field-work (7 to the 14th July = Lake Qalluuraq field-work. 14th to the 18th July = Kilarney Lake sampling). Geophysical imaging and further biogeochemical sampling will take place during the July 2009 field work. E mail discussions have taken place between Kelly Rose and Matthew Wooller concerning geological analyses of some of the cores already taken.

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