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Quarterly Progress Report (January – March 2012)

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 Alaska 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 this quarter has focused on preparing presentations of the results related to all of the projects Tasks. The next quarter will also be dedicated to publishing the primary data from this project. Once the bulk of this primary data is published (efforts and scope described below) the group will focus on synthesizing the results from the separate tasks. This synthesis effort will subsequently address the final milestone related to the project to "Integrate laboratory results and complete a comprehensive analysis of methane seepage in thermokarst lake settings". With many of the papers documenting the primary data from the project nearing completion the group's efforts in the next quarter can be turned towards this final milestone. Analyses have focused on four main lake locations referred to in this report: Lake Qalluuraq (referred to as Lake Q) and Lake Teshekpuk (both on Alaska's North Slope) and Lake Killarney and Goldstream Bill Lake (both in Alaska's interior). Additional sites (Burial Lake and Quartz Lake) have been added by Wooller to supplement Task 8. Analyses of samples from Year 1 fieldwork are complete and data from this fieldwork and sites are being included in a range of papers and presentations (see below). Analyses of samples collected from Year 2 fieldwork at Lake Teshekpuk are being completed.

Tasks 1 - 4 and 6: These tasks relate to field activities and have been completed and reported in previous quarterly reports.

Task 5.0 – Quantifying the short-term variability in methane emissions. Katey Walter Anthony:

We continue to analyze data from the Fairbanks thermokarst lake site, and are completing field data collection this summer. During the last quarter we worked specifically on an ice growth model that takes methane ebullition into account so that we can provide better estimates of the seasonality of methane emissions. Walter Anthony worked on two articles for publication. One article includes data collected in this project on the Lake Q flux rates, gas geochemistry and isotopes. The second paper considers the problem of spatial heterogeneity in ebullition seepage for estimating methane emissions from lakes. This DOE project will be acknowledged in both publications.

Task 7.0 - Methane oxidation in Alaskan thermokarst lakes. Mary Beth Leigh (UAF), Ruo He (UAF), Pohlman (USGS):

Work on microbial studies during this quarter has focused on polishing, submission and revision of manuscripts reporting the identity and activity of methanotrophs in lake sediments and water. One manuscript is now in print (online) and two others are in press. These three manuscripts are in the three top ranked journals in the field of environmental microbiology and microbial ecology.

Manuscripts in print

He, R. M. J. Wooller, J. W. Pohlman, J. Quensen, J. M. Tiedje, **M. B. Leigh.** (2012) Identification of functionally active aerobic methanotrophs in sediments from an arctic lake using stable isotope probing. *Environmental Microbiology.* Article first published online: 20 MAR 2012. DOI: 10.1111/j.1462-2920.2012.02725.x

Manuscripts in press

He, R. M. J. Wooller, J. W. Pohlman, J. Quensen, J. M. Tiedje, **M. B. Leigh.** Diversity of active aerobic methanotrophs along depth profiles of arctic and subarctic lake water column and sediments. *The ISME Journal*. In press.

He, R. M. J. Wooller, J. W. Pohlman, J. Quensen, J. M. Tiedje, **M. B. Leigh.** Shifts in identity and activity of methanotrophs in arctic lake sediments in response to temperature changes. *Applied and Environmental Microbiology*. In press.

Manuscripts in preparation

He, R. M. J. Wooller, J. W. Pohlman, J. Quensen, J. M. Tiedje, **M. B. Leigh.** Methane-derived carbon flows in microbial community in arctic lake sediments assessed by stable isotope probing of DNA and phospholipid fatty acids. *Manuscript in preparation.*

He, R. **M. J. Wooller**, **J. W. Pohlman**, J. Quensen, J. M. Tiedje, **M. B. Leigh**. Anaerobic methane oxidizers active in an arctic lake methane seep. *Manuscript in preparation.*

Task 8.0 - Establishing a long-term record of the variability in methane emissions in relation arctic climate change. Matthew Wooller (UAF) and Pohlman (USGS):

The analyses of Lake Q are complete and published in a special issue of JoPL dedicated to climate change records from arctic lakes (below). The technologies developed and applied to analyze the Lake Q west core were also applied to two other long cores accessed by Wooller et al. (one from the Brooks range [Burial Lake] and covering the period ~25,000 years to present) and one from the discontinuous permafrost region in the interior of Alaska (Quartz Lake, ~12,000 year to present). A manuscript documenting some results from Quartz Lake is complete and has also been published on-line in the special issue of JoPL (below). Although this paper's emphasis is the past hydrology of the site the analyses of proxies of past methane have also been completed from the core and provide a record of over 11,000 years. A full manuscript is complete from Burial Lake and is still being circulated amongst the co-authors for comments. A manuscript focused on biomarker data from Lake Q is in progress. USGS funds partially supported Ben Gaglioti during this quarter to prepare samples from Lake Teshekpuk.

Manuscripts in press

Matthew J. Wooller, et al**.** (2012) Reconstruction of past methane availability in an Arctic Alaska wetland indicates climate influenced methane release during the past ~12,000 years. Journal of Paleolimnology. Online.

M.J. Wooller, J. Kurek, **B.V. Gaglioti**, L.C. Cwynar, N.Bigelow, J.D. Reuther, C. Gelvin-Reymiller, J.P. Smol (2012) An ~11,200 year paleolimnological perspective for emerging archeological findings at Quartz Lake, Alaska. Journal of Paleolimnology. Online.

Manuscripts in preparation

Matthew J. Wooller et al. (in preparation) A record of Late Quaternary climate change in the northwestern Brooks Range, Alaska

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