# Methane sources in Arctic thermokarst lakes of the North Slope of Alaska

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The coastal plain of Alaska is densely populated by thaw lakes, topographic features on the permafrost that result from thermokarst erosion. These lakes release greenhouse gases like methane ($CH_4$) that in some cases has been stored for thousands of years (geogenic $CH_4$). However, $CH_4$ also results from present-day organic matter mineralization (biogenic $CH_4$). The contribution of biogenic $CH_4$ production in Arctic thermokarst lakes in Alaska (ATLA) is not currently well understood. Thus, the present study was motivated by the desire to understand the potential for microbial $CH_4$ production in sediments of these lakes, the role of sediment geochemistry in controling the balance of geogenic vs. biogenic $CH_4$ production, and the temperature dependence of this proces. We collected sediment cores from 3 contrasting sites in 2 thermokarst lakes: one site in Siqlukaq Lake (Siq) and 2 sites in Sukok (Suk), one near an active, ebullient natural gas seep (SukS), and another away from the seep (SukB). Integrated analyses of pore water geochemistry, sedimentary organic matter and lipid biomarkers, stable carbon isotopes, $CH_4$ production experiments, and copy number of a methanogenic pathway-specific gene, *mcrA*, indicated the existence of different sources of $CH_4$ in the region. $CH_4$ from Siq is biogenic, but in SukS $CH_4$ is, indeed, mostly geogenic. Further, our results showed that methanogenic Archaea present in ATLA are temperature dependent in their use of *in situ* substrates for methanogenesis, and that the amount of $CH_4$ produced is directly related to the amount of labile organic matter in the sediments. As both geogenic and biogenic $CH_4$ production occur in ATLA, at different spatial scales and in response to different drivers (gas field seepage vs. access to carbon resources), this understanding may better constrain predictions of ecosystem response to global warming on the North Slope.