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## UNDERSTANDING THERMOKARST LAKE DYNAMICS IN ARCTIC ALASKA: CASE STUDIES BASED ON SEDIMENT CORES

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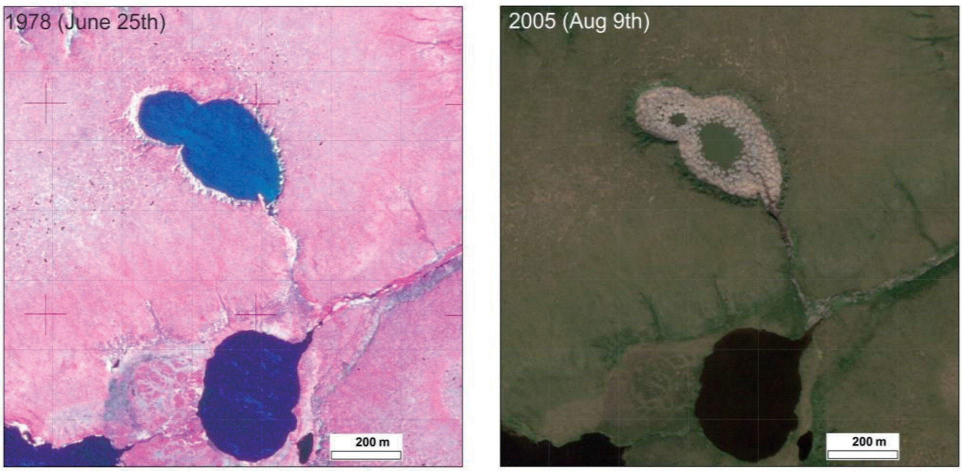
Arctic landscape dynamics are an indicator of long-term natural processes. Within the Arctic system, permafrost-related processes are key ecosystem drivers and influence regional landscape evolution, hydrology, etc. Thermokarst lake dynamics, involving initiation, expansion, drainage, and re-initiation, have reshaped vast Arctic lowlands in Siberia, Alaska, and Canada since the last deglaciation (~15,000 years ago). Today, thermokarst lakes across the circum-Arctic are responding quite variably to a warming. A multitude of remote sensing studies reports on losses in thermokarst lake area due to increased evapotranspiration and drying or rapid lake drainage, while increased thermokarst lake formation is reported from more northern regions. To understand these modern dynamics and place observations into a long-term context it is necessary to understand the paleodynamics of thermokarst lakes. A useful technique to achieve this is the use of core-based reconstructions of paleoenvironmental conditions during the lake history using various sedimentological, biogeochemical, and biological proxies.

We applied a multi-proxy approach on sediment cores making use of methods in sedimentology (grain size analyses, magnetic susceptibility), biogeochemistry (TN, TC, TOC, $\delta^{13}C$), geochronology ($^{14}C$, tephra chronology), and micropaleontology (ostracods, rhizopods). Our studies on modern but also recently drained basins in Arctic Alaska (USA) are based on sediment cores from the northern Seward Peninsula and the Teshekpuk Lake region and provide insights into past landscape dynamics since the late Pleistocene in these continuous permafrost regions.

GG basin on the northern Seward Peninsula, shown in the figure below, drained in spring 2005. Its lake initiation was radiocarbon-dated to about 300 years before present (BP) and was indicated by freshwater ostracods (e.g. *Fabaeformiscandina protzi*) and hydrophilic rhizopods (e.g. *Cyclopyxis kahli*). Before this, ice-rich silty and organic-rich sediments known as yedoma deposits accumulated during cold and dry conditions of the Late Mid-Wisconsin. An intermediate peaty layer with hydrophilic rhizopods indicates wet conditions from 44.5-41.5 ka BP. This possibly first thermokarst development was interrupted by a 1 m thick layer of tephra which could be associated with the South Killeak Maar eruption around 42 ka BP. As observed by satellite images, the modern lake drained between May and June 2015 possible due to increased discharge by thawing of snow which was possibly also blocking the outlet. Permafrost redeveloped since then from the surface down to 270 cm depth.

Our investigations demonstrate that lake development in the permafrost-affected terrestrial Arctic can be triggered but also interrupted by global climate change (e.g. rapid warming and wetting in the Holocene), by regional environmental dynamics (e.g. nearby volcanic eruptions and tephra deposition) or by local disturbance processes (e.g. lake drainage).

We found that Arctic lake systems and periglacial landscapes were sensitive to rapid change in the past. Field and remote sensing observations show that thermokarst lakes are vulnerable to rapid change in the present. Thus most likely thermokarst lake dynamics will have an important role for landscape and ecosystem change in a warming Arctic during the Anthropocene.




Infrared aerial image before the drainage (1978, June 25th) and Quickbird satellite image after the drainage of GG basin (2005, August 9th).