# Dissertations

## Normal and Extreme Sedimentation and Physical Processes in Lake Tuborg, Ellesmere Island, Nunavut



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Abstract
Lake Tuborg is a large lake on west-central Ellesmere Island, Nunavut. Part of the lake is meromictic, and contains trapped saltwater below about 55 m depth. The lake receives meltwater and sediments from multiple sources, including snowmelt and glacier melt. A lake process study was undertaken from 2001-2003 at Lake Tuborg that involved obtaining profiles of water temperature, salinity, transmissivity, and dissolved oxygen. Networks of short and long sediment cores were also obtained throughout the lake. During the last year of monitoring the lake and its sediments, a large catastrophic drainage of an ice-dammed lake occurred (a jökulhlaup). This was the largest jökulhlaup witnessed in Canada since 1947. Detailed measurements of lake conditions before, during, and after the jökulhlaup allowed the responses to be measured in great detail. The lake drained by floating its ice dam, an extremely rare drainage style in the Canadian High Arctic. The basin of Lake Tuborg closest to jökulhlaup inflow filled with fresh, cold and turbid water. A sill

separates this basin from the larger more distal meromictic basin, and this sill effectively blocked turbidity currents from entering this basin. Conclusions from this phase of research include (1) salinity and temperature in the saltwater basin were minimally affected by the jökulhlaup, and (2) at a deep, distal location, an identifiable thick, coarse-grained, non-erosive deposit was produced by the jökulhlaup. The above conclusions allowed the varved sedimentary record to be examined for similar deposits in the past, with the assumption that similar deposits could be found in the long core record, the sediments could be dated, and that previous jökulhlaup deposits would also be nonerosive. Varve-thickness counting, Cesium-137 dating, and particle size analyses showed that prior to 1960, no similar events occurred in roughly the last thousand years. In addition, only three large jökulhlaups have occurred in the last thousand years, all of which occurred after about 1960. This significantly improves the understanding of the history of the lake, the surrounding glaciers, and the paleoclimate of the region. The lake bottom deposits that were sampled before, during and after the 2003 jökulhlaup were extraordinarily unique. A major part of the work of characterizing these deposits involved determining the size of their constituent particles. Image analysis of sedimentary particles using backscattered electron microscope imagery is a method to determine particle size at extremely high resolution. This tool improves on existing techniques since it automates the process of statistically processing images, quantifies the percentage of disturbances on images, and allows for extremely small measurement windows relative to particle size by implementing special particle counting rules.