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Students: Lenny Ancuta, Jordan Epstein, Nathan Evenson, Samantha Falcon, Alexander Gonzalez, Tiffany Henderson, Conor McNally, Julia Nave, Maria Princen

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Keck Geology Consortium: Projects 2009-2010
Short Contributions – SVALBARD

HOLOCENE AND MODERN CLIMATE CHANGE IN THE HIGH ARCTIC, SVALBARD, NORWAY

Project Faculty: ***AL WERNER***: Mount Holyoke College
STEVE ROOF: Hampshire College
MIKE RETELLE: Bates College

DIRECTLY-CONTROLLED LICHEN GROWTH CURVES FOR WESTERN SPITSBERGEN, SVALBARD

TRAVIS BROWN: College of Wooster
Research Advisor: Greg Wiles

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CHRISTOPHER FISHER COLEMAN: Wesleyan University
Research Advisor: Suzanne O'Connell

LINNÉ GLACIER METEOROLOGICAL STUDY OF SURFACE ABLATION DURING THE 2006-2008 ABLATION SEASONS

FRANKLIN DEKKER: Franklin & Marshall College
Research Advisor: Christopher J. Williams

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JACALYN GORCZYNSKI: Mount Holyoke College
Research Advisor: Al Werner

334 YEARS OF CLIMATE CHANGE RECONSTRUCTED FROM VARVED SEDIMENTS: LINNEVATNET, SVALBARD

ALICE NELSON: Williams College
Research Advisor: Mea Cook

SEDIMENT CHRONOLOGY DEFINED BY CESIUM-137 IN THE DEEP MAIN BASIN OF PROGLACIAL LINNÉVATNET, WESTERN SPITSBERGEN, SVALBARD

ALEXANDER NERESON: Macalester College
Research Advisor: Karl Wirth

ALKENONE-INFERRED TEMPERATURE RECONSTRUCTION FROM KONGRESSVATNET, SVALBARD

DAVID A. VAILLENCOURT: University of Massachusetts Amherst
Research Advisors: William J. D'Andrea and Steven T. Petsch

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HOLOCENE AND MODERN CLIMATE CHANGE IN THE HIGH ARCTIC, SVALBARD, NORWAY

AL WERNER: Mount Holyoke College
STEVE ROOF: Hampshire College
MIKE RETELLE: Bates College

INTRODUCTION

Since 2003, we have run a summer REU site on Svalbard that directly involves students in important climate change research and exposes them to the challenges and rewards of conducting high latitude research. Although this project continues, we alternate between two field sites (Lake Linné and NyAlesund) and the Linné field site was available during the 2009 summer for a Keck-sponsored research program. With supplemental funding from Bates College we travelled north for three weeks of field work and then returned for a week of lab work at Mount Holyoke College

The main focus of the Svalbard program is monitoring modern processes in order to establish reliable transfer functions between sedimentation and meteorological/glaciological variables that will allow the lake sediment record to be better interpreted as a high-resolution record of late Holocene climate change. The Keck research builds on our 8+ years of research and monitoring in the Linné Valley and students pursued a wide variety of research activities and projects. Students were integrally involved in defining their own research questions and designing specific testable hypotheses.

FIELD SITE

The Arctic is an area of active research because it is highly sensitive to climate change and because climatically induced environmental changes in this region can instigate further changes of global consequence. Recently published data indicate that the Arctic is warming far faster than lower latitudes and even greater rates of change and ecosystem disruption are predicted with the continuing decay of the Arctic Ocean pack ice. The Svalbard archipelago is strongly influenced by the northern end of the warm Gulf Stream current, and therefore its climate is sensitive to changes in global scale oceanic circulation. Svalbard has warmed considerably during the last 90 years and climate proxies indicate even greater Holocene climate variability. Despite this, little is known of sub-century climate change and virtually nothing is known of decadal scale variability in this Arctic region. We have initiated a long term monitoring of the rapidly changing Arctic cryo/hydrosphere that will facilitate interpretation of high-resolution proxy records from the Svalbard region.

Svalbard, because of its high latitude location (76-80° N lat.) in the North Atlantic, its modern towns and facilities, its abundant glacial and marine environments, and its rich Quaternary history, provides an unparalleled opportunity for Arctic research. Svalbard is a unique environment in which to run a safe and effective polar undergraduate research program because it contains a rich assortment of glaciers and fjords, a variety of periglacial features, and a well-documented Quaternary history of glaciation and post-glacial marine emergence (Forman et al., 1987; Forman, 1990; Mangerud and Svendsen, 1990; Ingolfsson et. al., 1995). In addition, the modern town of Longyearbyen (Fig 1) has excellent facilities for supporting research (including airports and modern medical facilities). Previous and ongoing work indicates that significant Holocene environmental change occurred on Svalbard, and recent observations demonstrate that this region is experiencing rapid changes in climate (Serreze et al., 2000; Humlum, 2002; Moritz et al., 2002; ACIA, 2005; Overpeck et al., 2005).

PROJECT OBJECTIVES

Lake Linné is a glacier-fed lake and cores recovered from it are well laminated and previous core work and sediment trap data indicates that the layers are indeed annual couplets of silt and clay (i.e. varves). We are conducting research in the Linné Valley (Fig. 2) in order to establish linkages between climate, glacier mass balance, sediment transport, and sediment distribution in the lake. Our network of monitoring instruments deployed at the field site for the last eight years combined with our summer fieldwork provide a valuable and growing database critical to understanding the inherent variability of these natural systems. Research conducted during the 2009 field season was directed at providing a better understanding of sediment deposition in the lake, modeling upvalley glacier ablation, evaluating the potential of using alkenones as a proxy of environmental change and determining lichen growth rates during the past couple of decades.

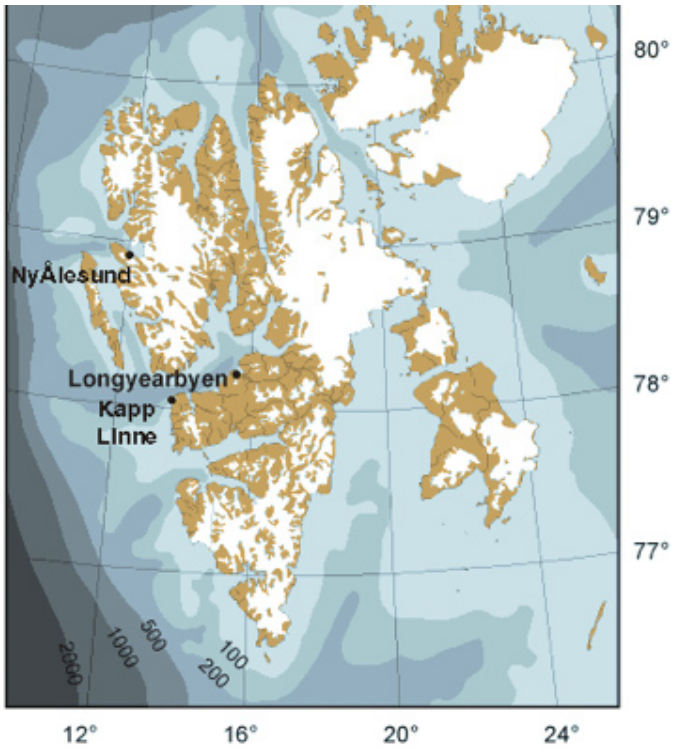

Figure 1. Kapp Linné and Linnévatnet. Isfjord Radio at Kapp Linné serves as our base of operations

Figure 2. Svalbard and REU sites (Kapp Linné and Ny Ålesund).

STUDENT PROJECTS

The field portion of our program ran from 20 July to 7 August, 2009 including the travel to and from Norway, cold water and firearm safety training and travel to and from the field site. After the field portion of the program we returned to Mount Holyoke College and students worked on their samples and worked with the data they collected until the 14th of August. During the 2009-2010 academic year, students worked on their projects at their home institution but shared data and samples.

Jacalyn Gorczynski (Mount Holyoke College):

Jacalyn worked on the five sediment trap moorings located through-out Lake Linné. Each mooring has between 2 and 5 traps positioned at different depth in order to document yearly sedimentation in the lake and to interpret sediment distribution processes within the lacustrine system. To better understand sediment distribution processes Jacalyn has used lake temperature anomalies to infer how sediment is transported from the inflow stream and into the lake.

Alex Nereson (McCalester College):

Alex focused his attention on sedimentation in the deep main basin of the lake distal to the inflow stream. Together with Alice (below) he recovered sediment cores, characterized the lamination stratigraphy and sampled his cores for Cesium-137 age dating. His work shows that sedimentation rates in the deep main basin are ca. 0.5 to 1 mm/year – a rate that is consistent with the thickness of the annual silt/clay couplets.

Alice Nelson (Williams College):

Cores recovered from the distal end of the deep main basin are very fine-grained and thinly laminated (see Alex, above) and those recovered from sites proximal to the inflow (mooring site C) have a coarser texture and much more complex lamination stratigraphies. As such the distal sties may be "too distal" (i.e., insensitive to changing conditions) and the proximal sites may be "too proximal" (i.e., too sensitive to sediment distribution processes). Alice recovered cores from an intermediate core site (I) to see if it might be the Goldilocks site!

Chris Coleman (Weslyan University):

Chris became interested in trying to make some sense of differences in sedimentation from year to year. To do this he compared annual sediment trap thicknesses and textures to year climate and glacier mass balance data. His project represents our first attempt to calibrate the annual sedimentation record of Lake Linné.

Franklin Dekker (Franklin and Marshall College):

Because most of the sediment that accumulates in Lake Linné comes from the Linné Glacier, knowing what factors influence the glacier mass balance (especially glacier ablation) is critical to interpreting the sediment record in Lake Linné. Franklin used daily and annual weather data and daily and annual glacier ablation (surface lowering data) to model the glacier response to meteorological conditions.

Travis Brown (Wooster College):

Twenty-four years ago as part of a job security plan, Al Werner established direct-measure lichen growth stations in five different locations on Spitsbergen, including the Linné Valley. Thirty-three lichen thalli of various sizes and representing two different species (*Pseudophebe miniscula* and *Rhizocarpon geographicum*) where re-measured during the 2009 field season and compared with the measurements taken in 1985. Travis calculated lichen growth rates and used them to date neoglacial moraines.

David Vaillencourt (University of Massachusetts Amherst):

Alkenones are long-chain hydrocarbon produced by certain algae and happily they occur in arctic lakes. They preserve well and their abundance serves as a reliable proxy of summer air temperature. Dave recovered sediment cores from Lake Kongress a small but deep meromictic lake just east of the Linné Valley and related measured alkenone abundance to historical records of summer temperatures.

PROJECT RESULTS

The research contributions of the 2009 Svalbard-Keck program build on previous research in the Linné valley that attempts to understand annual sedimentation in glacier-fed Lake Linné. The overarching goal of this work is to calibrate the late Holocene sediment record preserved in the lake. The projects of Jacalyn and Chris provide valuable insights into sediment distribution process in the lake and factors that influence annual textural and sedimentation rates changes in the proximal basins of Lake Linné. Alice and Alex compare the sedimentation in two different parts of the deep main basin and suggest that proximal core sites may be too noisy and that more distal core sites may be better for interpreting annual sedimentation records.

Franklin demonstrates with his study that summer air temperature is strongly associated with glacier

ablation. His results are consistent with previous work on a glacier to the south that indicates the temperature effect on glacier ablation can be reliably modelled.

Travis added to our understanding of lichen growth rates on Svalbard by comparing his determinations of "direct measure" rates (past 24 years) to those determined by Werner (1990) who used the "indirect" approach. Travis also further constrained the ages of Neoglacial lateral moraines in the Linné Valley.

Dave has demonstrated the utility and viability of using alkenone abundance to interpret past temperature from Arctic lake sediment records. The fact that they can be found in high Arctic lakes and that they appear to be a viable proxy of past environmental conditions is a significant contribution.

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