

ISEN Booster Funding
Final Report
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Assessing the Greenland Ice Sheet's Response to Warming: A Geologic Approach
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Rationale:

One of the most important unanswered questions regarding future climate change is “How fast will the great ice sheets shrink?” The fate of Earth’s two ice sheets, which cover most of Greenland and Antarctica, will determine the rate of future sea-level rise and thus the rate at which coastal cities must adapt. The geologic record uniquely provides an empirical means for assessing how ice sheets respond to dramatic warming. This ISEN-funded research aimed to reconstruct the temperature history of sites in both East and West Greenland through the Holocene, including the early Holocene Thermal Maximum – a period of insolation-driven warmth that reduced the extent of continental ice in the Arctic. By generating temperature reconstructions that can be compared with geologic data constraining the waxing and waning of the Greenland Ice Sheet over the same time period, this work contributes to understanding how (and especially how quickly) the ice sheet responds to warming climate.

Funded objectives:

Booster funding was aimed at broadening my incipient research program in Greenland, by allowing me to:

- Conduct field work in remote East Greenland, in order to recover sediment cores from a new field area that contrasts climatically with the sites of my previous pilot work in West Greenland
- Complete initial analyses (geochronology and paleoecology-based temperature reconstructions) of the new East Greenland samples and additional analyses of existing samples from West Greenland
- Establish a new collaboration with geologists at Dartmouth College whose complementary work focuses on reconstructing the Holocene history of glaciers in East Greenland
- Train NU undergraduates to contribute to paleolimnological research on Greenlandic sediments

Accomplishments:

- With ISEN support, I joined a field expedition to the Scoresby Sund region of East Greenland in summer 2011. Sediment cores recording recent (past few

centuries) and Holocene (past 11,000 years) sedimentation were successfully collected from three lakes.

- As proposed, ISEN funding allowed for initial geochronological (radiocarbon) and paleoecological (chironomid) analyses of the new sediment cores from the East, as well as supporting additional work by an NU undergraduate on an existing core from West Greenland. Our work in West Greenland was published in *Quaternary Science Reviews* in January 2013, and the first paper discussing the lake records from East Greenland is currently in review (see below). Chironomid analyses from the first two East Greenland lakes (informally named Last Chance Lake and Bunny Lake) are underway.
- This ISEN-funded collaboration with the Dartmouth team in East Greenland led directly to my participation in submitting a successful NSF proposal (see below), which will fund three years of related collaborative research in Northwest Greenland.
- As a direct result of my expanded role working on paleoclimate reconstructions on Greenland, I was invited to participate in a multidisciplinary NSF-funded workshop discussing ice sheet interactions with atmosphere and ocean.
- Five Northwestern undergraduates have thus far been engaged with research on sediment cores from Greenland.

Resulting grant proposal:

NSF Arctic System Sciences. *Collaborative Research: Response of the NW Greenland cryosphere to Holocene climate change*. With E. Osterberg and M. Kelly, Dartmouth College. \$155,885 to Axford. Jan 2012- Dec 2014. Status: Funded.

Resulting workshop invitation:

Interdisciplinary Approaches to Understanding Atmosphere/Ocean/Ice-Shelf/Ice-Sheet Interactions. Supported by the NSF Arctic System Sciences Program. December 2011.

Resulting peer-reviewed publications:

Axford, Y., Losee, S., Briner, J.P., Francis, D.R., Langdon, P.G., and Walker, I.R. 2013. Holocene temperature history at the western Greenland Ice Sheet margin reconstructed from lake sediments. *Quaternary Science Reviews* 59, 87-100.

Levy, L.B., Kelly, M.A., Lowell, T.V., Hall, B.L., Hempl, L.A., Honsaker, W.M., Lusas, A.R., Howley, J.A., and Axford, Y. Holocene glacier fluctuations near the eastern margin of the Greenland Ice Sheet, Bregne ice cap, Scoresby Sund, eastern Greenland. In review, *Quaternary Science Reviews*.