9-10-2013

Collaborative Research: Constraints on the last Ross Ice Sheet from Glacial Deposits in the Southern Transantarctic Mountains

Brenda Hall
Principal Investigator; University of Maine, Orono, brendah@maine.edu

My Desktop
Prepare & Submit Proposals
Proposal Status
Proposal Functions
Awards & Reporting
Notifications & Requests
Project Reports
Submit Images/Videos
Award Functions
Manage Financials
Program Income Reporting
Federal Financial Report History
Financial Functions
Grantee Cash Management Section Contacts
Administration
User Management
Research Administration
Lookup NSF ID

Preview of Award 0838615 - Final Project Report

Cover |
Accomplishments |
Products |
Participants/Organizations |
Impacts |
Changes/Problems

Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	0838615
Project Title:	Collaborative Research: Constraints on the last Ross Ice Sheet from Glacial Deposits in the Southern Transantarctic Mountains
PD/PI Name:	Brenda L Hall, Principal Investigator
Recipient Organization:	University of Maine
Project/Grant Period:	08/15/2009 - 08/31/2013
Reporting Period:	08/01/2013 - 08/31/2013
Submitting Official (if other than PD\PI):	Brenda L Hall Principal Investigator
Submission Date:	09/10/2013
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Brenda L Hall

Accomplishments

*** What are the major goals of the project?**

The major goal of this project was to reconstruct former LGM (and earlier) ice elevations along the lower reaches of Beardmore and Shackleton Glaciers. This was to be accompished by glacial geologic mapping of former drift limits, surface exposure-age dating of erratics at drift edges and along elevational transects, radiocarbon dating (where

possible) of algae from former ice-dammed ponds (also along elevational transects), and integration with a glaciological flow-line model. Former ice-surface elevations and thinning histories are important for understanding ice-sheet behavior during and after the last glacial maximum. These data help constrain models that examine ice-sheet stability and sea-level change, as well as allow one to place changes in Antarctic ice masses into a global climate context.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities:

This is a collaborative proposal. In this report, I refer only to work done at the University of Maine (primarily the glacial geologic mapping and radiocarbon dating). Details of the cosmogenic dating and glaciological modelling are to be found in the University of Washington report.

Our major activities are detailed in our annual reports. Here, I summarize the key points:

1) We carried out two field seasons - the first at Beardmore and the second at Shackleton. During the Beardmore season, we worked at The Cloudmaker, Mt. Kyffin, and Mt. Hope. At Shackleton Glacier, we visited Mt. Speed, Mt. Franke, Nilsen Peak, Gemini Nunataks, Taylor Nunatak, Thanksgiving Point, and Mt. Heekin. At each site, we examined the glacial deposits. Detailed maps were made of The Cloudmaker and Thanksgiving Point. Deposits at other locations (with the exception of Mt. Heekin where we did not have enough time) consisted only of erratics. We collected samples for radiocarbon dating at Thanksgiving Point and Mt. Franke. We also collected surface exposure-age samples from the older drifts at The Cloudmaker.

2) We analyzed samples for radiocarbon dating to place constraints on former ice elevation and the timing of retreat. We also analyzed a pilot data set of exposure-age samples from the older drifts at The Cloudmaker.

3) We supported and mentored three graduate students on this project.

4) We presented the results of this project at meetings, such as the WAIS meeting, the Comer Abrupt Climate Change meeting, and the Antarctic Earth Sciences meeting. Insights from this work also have been incorporated into an overview paper. A major paper specifically on Beardmore and Shackleton Glaciers is in progress.

Specific Objectives:

Significant Results:

We constrained former LGM ice elevation at the mouth of Beardmore and Shackleton Glaciers to ~1100 m - less than proposed originally in Denton et al. This elevation limits the size of LGM ice in the Ross Sea embayment to a modest-sized ice sheet. Our results preclude the presence of a giant LGM ice sheet in the Ross Sea region - something that would seem necessary if ~20 m of sea-level equivalent were to be produced from deglaciation in Antarctica at 14.6 ka during meltwater pulse 1A.

In addition to the cosmogenic dates from the University of Washington, reported on elsewhere, we obtained radiocarbon dates that bear on the timing of ice thinning. At Thanksgiving Valley (near Thanksgiving Pt), an ice tongue from Shackleton Glacier projected into the valley at the LGM. The LGM limit is well-defined as a fresh, gray drift limit. When the glacier projected into the valley, it dammed small, ice-marginal ponds. Because these ponds cannot exist without an ice dam (the valley topography slopes toward the glacier), the existence of the ponds places constraints on the presence and elevation of the glacier. From our data, we find that retreat from the maximum position was not under way until about ~10 ka. This

retreat continued, but was slow, until about 8 ka. At 8 ka, ice elevation appears to have dropped rapidly. These dates are consistent with cosmogenic data along the TAMS front at Beardmore Glacier (see Stone report) that show ice decline primarily in the Holocene and reaching present levels by about 7 ka. The rapid drop at 8 ka may relate to what appears to be widespread recession in the Ross Sea region between 7-8 ka. There is no evidence of any rapid change in ice level at the time of meltwater pulse 1A.

Key outcomes or
Other achievements:

*** What opportunities for training and professional development has the project provided?**

This work afforded opportunities for three graduate students at the University of Maine who worked on various aspects of the project. All three received training in the preparation of samples for chronologic analyses. Two of these students deployed into the field. One completed a thesis related to the project. One continues to work on research related to data gathered during this project during his postdoc.

*** How have the results been disseminated to communities of interest?**

Results from this project were presented at the WAIS meeting and the International Antarctic Earth Sciences meeting, reaching the primary communites of interest, as well as at other scientific meetings with broader audiences. For instance, I presented this work at the Comer Abrupt Climate Change Meeting. We also have displayed information about this project on our website, which is aimed primarily at the public. In addition, metadata are available in the Global Change Master Directory. Results, photographs, and experiences from this project are used regularly in classes at the University of Maine and at a Senior College and have been presented at elementary schools and to a senior assisted living community.

Products

Books

Dengler, E., Hall, B., Stone, J, and Conway, H. (2012). *Late Cenozoic glacial history of Shackleton Glacier, Antarctica* 19th Annual WAIS Meeting. Pack Forest, WA. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = No

Hall, B. (2011). *History of the Antarctic Ice Sheet in the Ross Sea sector at and since the last glacial maximum* 11th Intl. Symposium on Antarctic Earth Sciences. Edinburgh, Scotland. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Hall, B., Stone, J., Conway, H., Bromley, G., and Cowdery, S. (2010). *Deglaciation of the Ross Sea - implications for the behaviour of the West Antarctic Ice Sheet and sea-level change* PALSEA Conference. Bristol, England. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Book Chapters

Conference Papers and Presentations

Inventions

Nothing to report.

Journals

Hall, B., Denton, G., Stone, J., and Conway, H. (2013). History of the grounded ice sheet in the Ross Sea sector of Antarctica during the last glacial maximum and the last termination.. *Geological Society of London*. 381 doi:10.1144/SP381.5. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Licenses
Nothing to report.

Other Products
Metadata.

Metadata for our radiocarbon database have been submitted to the NASA Global Change Master Directory and can be found at http://gcmd.nasa.gov/getdif.htm?hall_0838615

Other Publications

Patents
Nothing to report.

Technologies or Techniques
Nothing to report.

Thesis/Dissertations
Dengler, E.. *Late Quaternary history of Shackleton Glacier*. (2013). University of Maine. Acknowledgement of Federal Support = Yes

Websites
Project Summary for Shackleton Glacier
http://umaine.edu/earthclimate/faculty-staff/faculty-and-staff/brenda-hall/glacial-geology-and-geochronology-research-group/past-projects/

This website includes short descriptions of our present and past projects designed for the public.

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Hall, Brenda	PD/PI	2
Bromley, Gordon	Postdoctoral (scholar, fellow or other postdoctoral position)	9
Dengler, Elizabeth	Graduate Student (research assistant)	12
Jackson, Margaret	Graduate Student (research assistant)	9

Full details of individuals who have worked on the project:

Brenda L Hall
Email: Brendah@Maine.Edu
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 2

Contribution to the Project: This person planned and implemented the project, participated in field work, mentored students, and helped interpret and write up results. Person months worked is per year, not per project.

Funding Support: NSF/Other

International Collaboration: Yes, Antarctica
International Travel: Yes, Antarctica - 0 years, 1 months, 0 days; United Kingdom - 0 years, 0 months, 5 days

---

Gordon Bromley
Email: gordon.r.bromley1@maine.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 9

Contribution to the Project: Gordon participated in the first year of this project as a graduate student (funded by NSF). He was responsible for the Beardmore Gl. part of the project and took part in the fieldwork and logistical preparation. Gordon has remained interested in the project and participated in the last project year while a postdoc (but not funded by this grant). During this time, he has been preparing samples for cosmogenic dating.

Funding Support: NSF/Other

International Collaboration: Yes, Antarctica
International Travel: Yes, Antarctica - 0 years, 1 months, 0 days

---

Elizabeth Dengler
Email: lizdengler@gmail.com
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Liz was the primary graduate student for the Shackleton Glacier portion of this project. She participated in field work and lab work, and wrote a thesis related to the subject. She actually worked more than 12 months over the course of the project (21 months), but I cannot enter a number >12 in the box above..

Funding Support: NSF

International Collaboration: Yes, Antarctica
International Travel: Yes, Antarctica - 0 years, 1 months, 0 days

---

Margaret Jackson
Email: margaret.s.jackson@maine.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 9

Contribution to the Project: Margaret participated in the preparation of samples for cosmogenic dating, in the preparation of radiocarbon samples, and in numerous smaller tasks related to the project.

Funding Support: NSF

International Collaboration: Yes, Antarctica
International Travel: No

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
University of Washington	Academic Institution	Seattle

University of Washington	Academic Institution	Seattle

Full details of organizations that have been involved as partners:

University of Washington

Organization Type: Academic Institution
Organization Location: Seattle

Partner's Contribution to the Project:
In-Kind Support
Facilities
Collaborative Research

More Detail on Partner and Contribution: This is a collaborative project. All parties share in data acquisition and interpretation.

What other collaborators or contacts have been involved?

NO

Impacts

What is the impact on the development of the principal discipline(s) of the project?

Our work shows that ice elevation at the last glacial maximum was no more than 1100 m at the mouths of both Beardmore and Shackleton Glaciers. This is less than previously reconstructed for the area. Our work also has resulted in the first radiometric chronologies for the lower halves of Beardmore and Shackleton Glaciers. The impact of these dates is that we can show the thinning history of these two glaciers in response to Ross Sea deglaciation.

What is the impact on other disciplines?

Understanding the interactions between ice sheets and sea level is an important goal with implications for future predictions. At present, a large debate surrounds the Antarctic contribution to meltwater pulse 1A, thought to be a 15-20 m rise in sea level in 300-500 yrs at ~14.6 ka. Low-latitude data, along with geophysical modelling, have been used to point to Antarctica as the sole or major source of this event. For this to have happened, significantly more ice must have existed in Antarctica at the last glacial maximum than is currently envisioned. Moreover, all of this ice would have had to have been lost to the sea at 14.6 ka. Our data are not in support of this hypothesis and suggest that meltwater pulse 1A - if it did indeed come from Antarctica - did not come from the Ross Sea sector.

What is the impact on the development of human resources?

This project resulted in the training of graduate students. All three still remain in science. One is a postdoc (who continues to work on samples collected in this project), another just started a Ph.D. at Dartmouth, and the third is now employed as a glacial geologist by the Minnesota Geological Survey.

What is the impact on physical resources that form infrastructure?
Nothing to report.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?

Nothing to report.

What is the impact on technology transfer?

This project resulted in technology transfer of lab techniques between the University of Washington and the Univesity of Maine cosmogenic labs.

What is the impact on society beyond science and technology?

Sea-level change - and the role of the polar ice sheets - remains one of the most critical environmental problems facing society today. Our work bears on past sea-level changes and ice-sheet behavior. An understanding of the nature and causes of past sea-level change can help us to predict future changes.

Changes/Problems

Changes in approach and reason for change
Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them
Nothing to report.

Changes that have a significant impact on expenditures
Nothing to report.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.