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AMS Radiocarbon Chronology of Glacier Fluctuations in the South Shetland Islands During the Last Glacial/Interglacial Hemicycle:Implications for Global Climate Change

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Principal Investigator: Hall, Brenda L.
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Title:

AMS Radiocarbon Chronology of Glacier Fluctuations in the South Shetland Islands During the Last Glacial/Interglacial Hemicycle:Implications for Global Climate Change

Project Participants

Senior Personnel

Name: Hall, Brenda
Worked for more than 160 Hours: Yes
Contribution to Project:
Brenda Hall is the principal investigator on this project. She has been involved in all stages of planning and preparation for the field work and spent 2.5 months in the South Shetland Islands working on this project.

Post-doc

Graduate Student

Undergraduate Student

Name: Smethurst, Naomi
Worked for more than 160 Hours: No
Contribution to Project:

Name: Faloon, Katrina
Worked for more than 160 Hours: No
Contribution to Project:

Name: Hatch, William
Worked for more than 160 Hours: No
Contribution to Project:

Name: Smith, Colby
Worked for more than 160 Hours: No
Contribution to Project:

Name: Marcotte, Peter
Worked for more than 160 Hours: No
Contribution to Project:

Technician, Programmer

Other Participant

Name: Evans, John
Worked for more than 160 Hours: Yes
Contribution to Project:
John Evans, head of special projects for Raytheon, accompanied me as my field assistant and mountaineer during 2002/2003. His knowledge of geology also contributed to the overall project.

Research Experience for Undergraduates

Name: Perry, Ethan

Worked for more than 160 Hours: Yes

Contribution to Project:

Ethan Perry was the field assistant on this project and spent 2.5 months in the South Shetland Islands. He also has been involved in the research after his return and has talked to school children about his experiences. During the summer, he completed a detailed study of the sedimentology of beach sediments in the South Shetland Islands.

Years of schooling completed: Junior

Home Institution: Same as Research Site

Home Institution if Other:

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2002 2001

REU Funding: REU supplement

Name: Roy, Alex

Worked for more than 160 Hours: Yes

Contribution to Project:

Alex has been analyzing beach and till sediments from the South Shetland Islands. He also has been trying to identify the sources of far-travelled clasts by looking at their petrology.

Years of schooling completed: Junior

Home Institution: Same as Research Site

Home Institution if Other:

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2003 2002

REU Funding: No Info

Organizational Partners

ETH-Zurich

Dr. Susan Ivy-Ochs of ETH-Zurich has been working with us to try to obtain exposure-age dates from some of the moraines. As a result, our cost for the analyses was greatly reduced.

Other Collaborators or Contacts

I met with Dr. David Sugden to discuss his past work in the area. I
also have discussed collaborative efforts with Dr. Sugden and Dr.
Michael Bentley, who are working farther south in the Peninsula region. Dr. John Stone and I have discussed collaborative work with exposure-age dating of samples collected during 2002-2003. This resulted in a proposal to NSF (pending). I am also in contact with Dr. Fred Taylor, who has a grant to examine ongoing uplift of the South Shetland Islands. His recent data will help me to interpret my data on relative sea-level change over the past 6000 years. My relative sea-level data will give him a paleoenvironmental perspective on recent rates of motion.

Activities and Findings

Research and Education Activities:

During the course of this grant, we have participated in two field seasons in the South Shetland Islands. The first was spent mapping glacial and raised marine deposits on King George and Livingston Islands. The second was based on the Laurence M. Gould and involved primarily day trips to Livingston, Low, and King George Islands on an opportunity basis. During these trips we mapped glacial deposits and collected samples for dating. At home, we have prepared maps and submitted samples for radiocarbon and exposure-age dating. REU students Ethan Perry and Alex Roy have been analyzing beach sediments to look for changes in roundness, weathering, and grain size that may relate to changes in sea-ice cover. Alex Roy also has been identifying the sources for far-travelled clasts by preparing and analyzing thin sections. Finally, we also have shared our experiences with the public through correspondence, public lectures, and visits to schools. Results from this research have been presented at meetings and incorporated into geology courses at the University of Maine. A description of project data can be found at http://gcmd.nasa.gov/getdif.htm?South_Shetland_Is_Beach_Data

Findings:

One thing that stands out in our minds is how little the landscape of the South Shetland Islands has been modified by glaciation. The dominant landscape feature is a series of marine platforms with beach material that shows little evidence of glacial disturbance. We conclude that either ice in the South Shetland Islands was not much more extensive than at present during the LGM or that ice cover was thin and cold-based. As one possibility, we suggest that ice expanded as sea-level dropped during the last glacial maximum. Ice would have terminated at the shore, similar to today. This is consistent with information from the South Shetland Islands suggesting only minor ice expansion at the LGM, but cannot yet be proven conclusively.

Although in most places evidence of glaciation is scarce, there is an abundant record of glacial activity within a kilometer of present outlet glaciers. We identified at least four sets of moraines in some of these areas. Based on their cross-cutting relationships with raised beaches, others have suggested that all of these moraines relate to the Little Ice Age. However, we found that the proposed relationships with at least some of the beaches are in error and that some of the moraines may, in fact, be much older. At present, we have a single exposure-age date from one of these moraines. Although it has a large error, it dates to about 18,000 years before present - much too old for a Little Ice Age moraine. More dates are needed to be sure of the age of the moraine. However, it is possible that some moraines formerly attributed to the late Holocene may in fact relate to the last glacial maximum. If so, they would show that ice extent at the last glacial maximum was considerably smaller than previously thought. During last year's field season, we collected exposure-age samples that will help to resolve this issue.

We also have obtained relative sea-level data. A preliminary curve, constructed from more than 40 dates of organic material in raised beaches shows a complex history, with at least two transgressions during the Holocene and possibly evidence of tectonic influence. Despite the complex curve, it is possible to determine that most coastal areas were deglaciated by ~6000 years B.P., if not earlier. We place the Holocene marine limit at about 22 m elevation, based on geomorphologic data. Higher beaches and platforms must relate to a combination of isostatic rebound from previous glaciations and tectonic uplift. We are currently collaborating with Dr. Fred Taylor, who is studying modern rates of uplift in the South Shetland Islands. This collaboration will allow us to place limits on the possible tectonic component of relative sea-level change.

There is also evidence of late Holocene ice fluctuations in the South Shetland Islands. More than 20 new radiocarbon dates of moraines on King George Island indicate an ice advance that culminated within the past 200 years. We correlate this with the Little Ice Age, although note that the scale of advance is much less than that of traditional Little Ice Age expansions north of the Antarctic convergence.

Training and Development:

This project has provided opportunities for undergraduate students
to become immersed in a research project. Ethan Perry participated as a full partner in the field research. He also is involved in writing a paper to come out of this work. Ethan Perry, along with Alex Roy, both have participated as REU students and have had the opportunity to carry out independent research related to this project. Other undergraduate students also have been involved in the research. Data gathered in this project have been incorporated into undergraduate and graduate courses, including GES 121 (Humans and Global Change) and GES 441 (Glacial Geology).

Outreach Activities:

The PI has continued her elementary school outreach activities through visits and correspondence with students while in the field. Ethan Perry talks about his experiences frequently in several secondary school classrooms. The PI also has given lectures open to the public, most recently one at the Northern Maine Museum of Science.

Journal Publications

Brenda Hall
Ethan Perry, "Variations in ice-rafted detritus on beaches in the South Shetland Islands: A possible climate proxy", Antarctic Science, p. , vol. , (2003). Submitted

Brenda Hall, "Late Holocene advance of Collins Ice Cap, South Shetland Islands", Boreas, p. , vol. , ( ). In final stages of preparation

Brenda Hall, "Holocene relative sea-level changes in the South Shetland Islands", Antarctic Science, p. , vol. , ( ). In final stages of preparation

Hall, B.L., "An overview of late Pleistocene glaciation in the South Shetland Islands", Antarctic Research Series, p. 103, vol. 79, (2003). Published

Books or Other One-time Publications

Hall, B.L., "Glaciation and relative sea-level changes in the South Shetland Islands", (2002). abstract, Published
Collection: International workshop on Antarctic Peninsula Climate Variability
Bibliography: Hamilton College, Clinton, NY

Hall, B.L., "Geomorphological evidence of neotectonics and glacial isostasy", (2001). abstract, Published
Collection: Antarctic Neotectonics Conference
Bibliography: Siena, Italy

Web/Internet Site

URL(s):

http://www.ume.maine.edu/iceage/

Description:

To reach the site, go the above URL, click on Directory, then on Brenda Hall on the faculty page, then on Research Projects.

Other Specific Products

Contributions

Contributions within Discipline:

This work is contributing to an understanding of glaciation of the South Shetland Islands and the timing of ice fluctuations relative to other locations in the world. The new research suggests that LGM ice extent in the South Shetland Islands may have been overestimated in the past and that ice advance was minor and/or the glaciers were cold-based. There is no evidence (yet) of a late-glacial readvance, although exposure ages of samples collected from moraines last year may resolve this issue. There is evidence of a late Holocene advance at the same time as the Little Ice Age.

Contributions to Other Disciplines:

This research is of interest to people studying Antarctic neotectonics and provides a record of relative sea-level change for the South Shetland Islands. Results from this work were presented at an Antarctic neotectonics (ANTEC) meeting. In addition, Dr. Fred Taylor and I are sharing data on rates of relative sea-level change in the South Shetland Islands. I have ~6000 years of data on major changes in the level of the land relative to the sea. Dr. Taylor is studying the modern rates of plate motion. Our data complement each other.

Contributions to Human Resource Development:

This project has provided professional training for several undergraduate geology students, including two who have been involved in substantial independent research projects. Data from this project have been incorporated into a glacial geology class (GES-441)and into an introductory class on humans and global change (GES-121).

Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

This project is aimed at attacking one facet of the complex problem of global climate change. Although the research has no immediate impact on public welfare, an understanding of climate change ultimately may have a profound impact.

Categories for which nothing is reported:

Any Product

Contributions: To Any Resources for Research and Education