GLACIOLOGY

Ice is indisputably the defining characteristic of Antarctica. The entire continent (with a few exceptions such as the McMurdo Dry Valleys and some lakes and mountains) is covered by ice sheets that have been laid down over eons, if the term "sheets" can be used to describe a dynamic mass that is several thousand meters (m) thick, that is larger than most countries, that rises over 2,000 m above sea level (and peaks in an ice dome nearly twice that high in the east), and that is heavy enough to depress the bedrock beneath it some 600 m. Actually, the continent has two distinctly different sheets: the much larger East Antarctic Ice Sheet, which covers the bedrock core of the continent, and the smaller, marine-based West Antarctic Ice Sheet, which is beyond the Transantarctic Mountains and overlays a group of islands and waters.

Near the Erebus Glacier tongue on Ross Island, Antarctica

NSF photo by Melanie Conner

The Antarctic Glaciology Program is concerned with the history and dynamics of the antarctic ice sheets; this includes research on near-surface snow and firn, floating glacier ice (ice shelves), glaciers, ice streams, and continental and marine ice sheets. These species of ice facilitate studies on ice dynamics, paleoenvironments (deduced from ice cores), numerical modeling, glacial geology, and remote sensing. Current program objectives include the following:

- correlating antarctic climatic fluctuations (from ice-core analysis) with data from arctic and lower-latitude ice cores;
- integrating the ice record with terrestrial and marine records;
- investigating the physics of fast glacier flow with emphasis on processes at glacier beds;
- investigating ice-shelf stability; and
- identifying and quantifying the relationship between ice dynamics and climate change.

U.S. component of the International Trans-Antarctic Scientific Expedition: South Pole to northern Victoria Land traverse.

Paul Mayewski and Gordon Hamilton, University of Maine.

We will operate a science management office for a pilot ice-core drilling and analysis program to test the feasibility of obtaining well-dated, high-resolution isotope and chemistry records from East Antarctica. Shallow ice cores will be obtained from two locations:

- 100 kilometers from the South Pole toward the Pole of Inaccessibility, as an extension of the Byrd Station-to-South Pole International Trans Antarctic Scientific Expedition (ITASE) traverse; and
- Taylor Dome, near the original deep-coring site.

AGO 3 and AGO 4 (automated geophysical observatories) may also be sampled as part of a logistics traverse to these sites.

All of the cores collected will be examined at very high resolution and analyzed for major ions. Results from this calibration work, along with those from another project that is analyzing stable isotopes, will be used to help plan a larger program, with the objective of mapping the spatial expression of climate variability in East Antarctica.

In addition, we will organize a community workshop to coordinate the second phase of U.S. ITASE, as well as one workshop a year, for 2 years, dedicated to writing and preparing scientific papers from phase 1 of U.S. ITASE. Further, we will use satellite image mapping to select routes for the follow-on traverse in East Antarctica. We also will produce a summary that will be made available to the community to help with planning related field programs such as deep ice radar, firn radar profiling, atmospheric chemistry, ice coring, snow surface properties for satellite observations, ice surface elevation, and mass balance. (I–153–M; NSF/OPP 02–29573)

Dynamics and climatic response of the Taylor Glacier system.

Kurt Cuffey, University of California–Berkeley, and David Morse, University of Texas–Austin.

Taylor Glacier drains the Taylor Dome region of the East Antarctic Ice Sheet and terminates in Taylor Valley, one of the ice-free or dry valleys of southern Victoria Land. This glacier provides a crucial link between two intensively studied antarctic environments: the Taylor Dome, from which a 130,000-year ice-core paleoclimate record has recently been extracted, and the dry valleys, a pivotal ecological research site and a focus of geomorphology and glacial geology studies.

The goal of our research is to significantly improve our understanding of how Taylor Glacier flows and responds to changes in climate. It has been widely recognized that such information is central to understanding the changing physical environment of the Taylor Valley ecosystem and is required for linking interpretations of the Taylor Dome paleoclimate record to interpretations of the geomorphology and glacial geology of the dry valleys. This work will thus make an important contribution to ongoing efforts to exploit the Taylor Dome–dry valleys system to build a uniquely comprehensive view of regional long-term environmental changes.

Our work has two complementary components: field research and numerical modeling. Two field seasons will be used to measure velocity, surface strain rate, mass balance, ice thickness, glacier bed reflectance, and subglacial topography along a nearly complete longitudinal transect of the Taylor Glacier and along select cross-valley transects as well. We will use this information to constrain numerical models of ice and heat flow for the Taylor Dome–Taylor Glacier system. These calibrated models will be used in turn to analyze the time-dependent response of the glacier to changes in climate. The synthesis of these results will be aimed at improving our understanding of the glacial geomorphology of Taylor Valley and at illuminating impacts on the Taylor Valley lakes ecosystem. (I–161–M; NSF/OPP 01–25579 and NSF/OPP 01–26202)

South Pole atmospheric nitrate isotopic analysis (SPANIA).

Mark Thiemens and Joel Savrino, University of California–San Diego.

Despite decades of research, several important issues in antarctic atmospheric science are presently inadequately resolved, including quantifying the sources of nitrate aerosols over time. Today, little is known about past denitrification of the stratosphere in high-latitude regions. This lack of knowledge significantly limits our ability to understand the chemical state of ancient atmospheres and therefore evaluate present and past-coupled climate/atmosphere models. The role of nitrogen in environmental degradation is well known, and atmospheric aerosols have now been shown to have a mass-independent oxygen isotopic content.

We will therefore perform a detailed laboratory analysis of the mass-independent isotopic composition of processes associated with atmospheric nitrate trapped in the snow pack at the South Pole. Specifically, we will test whether the oxygen isotopes ^{16}O, ^{17}O, and ^{18}O of nitrate can be used to probe the denitrification of the antarctic stratosphere.

We will also investigate the stable oxygen isotope ratios of nitrate collected both in real time and from the snow in Antarctica. Full-year nitrate aerosol collections, with resolution time horizons of a week, will be performed at the South Pole. Weekly aerosol collections will help us identify any seasonal trend in the ^{17}O excess anomaly and eventually link it to the denitrification of the antarctic stratosphere.

In addition, we will use this data set to test our assumption that the oxygen isotopic anomaly of nitrate is mainly formed in the stratosphere and is well preserved in the snow pack. If this is true, we will for the first time resolve an atmospheric signal extracted from a nitrate profile. The snow pit will allow us to see any trend in the data over a time span of many decades. (I–165–M/S; NSF/OPP 01–25761)

Late Quaternary history of Reedy Glacier.

John Stone, University of Washington, and Brenda Hall, University of Maine.

The stability of the marine West Antarctic Ice Sheet remains an important, unresolved issue for predicting future changes in sea level. Studies indicate that the mass balance of the ice sheet today could be negative or positive. The apparent difference could stem in part from short-term fluctuations in flow. By comparison, geologic observations provide evidence of behavior over much longer time scales. Recent work suggests that deglaciation of both the Ross embayment and coastal Marie Byrd Land continued into the late Holocene (about the past 2,000 years) and leaves open the possibility of ongoing deglaciation and grounding-line retreat. However, previous work in the Ross embayment was based on data from just three locations that are all far north of the present grounding line. Additional data from farther south are needed to determine whether the recession has ended or whether the rate and pattern of deglaciation inferred from our previous study still apply.

We will therefore reconstruct the evolution of Reedy Glacier, in the southern Transantarctic Mountains, since the last glacial maximum. Because the glacier emerges from the mountains above the grounding line, its surface slope and elevation should record changes in the thickness of grounded ice in the Ross Sea up to the present. The deglaciation chronology of Reedy Glacier can thus indicate whether the Holocene retreat of the West Antarctic Ice Sheet ended thousands of years ago or is still continuing.

Over two field seasons, we will map, date, and correlate moraines at sites along the length of the glacier. We will make radar and global positioning system measurements to supplement existing ice thickness and velocity data. We will also construct a model of glacier dynamics and use it to relate geologic measurements to the grounding-line position downstream. Ultimately, we will integrate the mapping, dating, and ice-modeling components of the study into a reconstruction that defines changes in ice thickness in the southern Ross Sea since the last glacial maximum and relates these changes to the history of grounding-line retreat.

Our work directly addresses the key goals of the West Antarctic Ice Sheet Initiative, which are to understand the dynamics, recent history, and possible future behavior of the West Antarctic Ice Sheet. (I–175–M; NSF/OPP 02–29314 and NSF/OPP 02–29034)

Refining a 500,000-year climate record from the Mount Moulton blue ice field in West Antarctica.

Todd Sowers, Pennsylvania State University; William C. McIntosh and Nelia W. Dunbar, New Mexico Institute of Mining and Technology; and James White, University of Colorado–Boulder.

The summit crater of Mount Moulton contains a 600-meter-thick, horizontally exposed section of ice with intercalated tephra layers from nearby Mount Berlin. Argon-40/argon-39 dating of the thick, near-source tephra indicates that the age of the horizontal ice section ranges between 15,000 and 492,000 years. Thus, the Mount Moulton site offers an unparalleled repository of ancient West Antarctic snow and trapped air that can be used to investigate climate over much of the past 500,000 years. The planar nature and consistent dips of the tephra layers suggest that although the ice section has thinned, it is otherwise undeformed.

We visited the Mount Moulton site during the 1999–2000 field season, at which time we collected a horizontal core representing approximately 400 meters of ice, ranging from 15,000 to more than 480,000 years old. In addition to this horizontal core, we took samples at various depths to test the quality of the climate record in the ice. We also collected 40 intercalated tephra layers to provide a chronology for the ice section. The results of this first effort are extremely encouraging. There is clearly a usable record of past climate extending back beyond 140,000 years.

There is work to do, however, to realize the full potential of this horizontal ice core. The elemental and isotopic composition of trapped gases suggests some contamination by modern air. Since gas cross-dating of ice cores is the current standard by which climate records are compared, we need to understand why and how the gas record is compromised before adding Mount Moulton to our arsenal of ice-core paleoclimate records.

Our research has the following objectives:

- to evaluate more thoroughly the integrity of the climatic record through shallow drilling of blue ice, as well as the snow field upslope from this area;
- to improve the radioisotopic dating of specific tephra layers;
- to obtain baseline information about modern snowfall deposition, mean annual temperature, and wind pumping around the summit of Mount Moulton; and

- to study how firn densification differs when surface accumulation changes from net accumulation to net ablation. (I–177–M; NSF/OPP 02–30021, NSF/OPP 02–30348, and NSF/OPP 02–30316)

Glaciology of blue ice areas in Antarctica.

Gordon Hamilton, University of Maine.

A horizontal ice core was collected at the Mount Moulton blue ice field in West Antarctica, and preliminary analyses of the sample suggest that a climate record of roughly 500,000 years is preserved in the ice there. We aim to contribute to the understanding of the Mount Moulton record by assessing the possibility that the ice-flow record has been deformed.

Specifically, we will

- resurvey an existing global positioning system (GPS) grid to determine ice velocities and strain rates,
- use ground-penetrating radar (GPR) to image the internal stratigraphy of the ice,
- use GPR to map subglacial topography, and
- collect two firn ice cores to determine stratigraphic continuity and modern accumulation rates.

In addition, we will build on the recognition of blue ice areas as archives of long climate records by conducting reconnaissance studies for a potential horizontal ice-core location in the Allan Hills of East Antarctica. We will

- resurvey an existing GPS to confirm earlier ice-velocity measurements and calculate strain rates,
- survey several profiles using GPR to image internal stratigraphy and bedrock geometry,
- collect one or two shallow firn cores to study accumulation rates,
- conduct dielectric profiling to study stratigraphic continuity over a 1- to 2-kilometer profile, and
- collect meteorites.

By collecting relevant measurements of ice flow and subglacial topography and taking samples of material, we will be able to assess the preservation of the stratigraphic sequences and contribute to the understanding of blue ice areas. (I–178–M; NSF/OPP 02–29245)

How thick is the convective zone? A study of firn air in the megadunes near Vostok.

Jeffrey Severinghaus, University of Rhode Island.

In the megadunes, extremely low snow accumulation rates lead to structural changes (large grains, pipes, and cracks) that make the permeability of firn-to-air movement orders of magnitude higher than normal. The unknown thickness of the convective zone has hampered the interpretation of ice-core nitrogen/argon isotope ratios as indicators of past firn thickness, which is a key constraint on the climatically important variables of temperature, accumulation rate, and gas age–ice age difference. We will therefore study the chemical composition of air in the snow layer (firn) in a region of megadunes near Vostok Station to test the hypothesis that a deep convective zone of vigorous wind-driven mixing can prevent gas fractionation in the upper third of the polar firn layer. Studying this extreme end-member example will better define the role of the convective zone in gas reconstructions.

We will pump air from a profile of about 20 depths in the firn to definitively test for the presence of a convective zone based on how well inert gas isotopes fit a molecular- and eddy-diffusion model. Permeability measurements on the core and two-dimensional air flow modeling will permit a more physically realistic interpretation of the isotope data and will relate mixing vigor to air velocities. We will also test a new proxy indicator of convective zone thickness on firn and ice-core bubble air; this indicator is based on the principle that isotopes of slow-diffusing heavy noble gases (krypton, xenon) should be more affected by convection than isotopes of fast-diffusing nitrogen.

Finally, we intend to test the hypothesis that the megadunes and a deep convective zone existed at the Vostok site during glacial periods; this would explain the anomalously low nitrogen/argon isotope ratios in the Vostok ice-core glacial periods. Our work will clarify phase relationships of greenhouse gases and temperature in ice-core records, with implications for understanding past and future climates. (I–184–M; NSF/OPP 02–30452)

Characteristics of snow megadunes and their potential effects on ice-core interpretation.
Theodore A. Scambos, University of Colorado–Boulder; Mary Albert, U.S. Cold Regions Research Laboratory; Mark Fahnestock, University of New Hampshire; and Christopher Shuman, National Aeronautics and Space Administration/Goddard Space Flight Center.

Vast portions of the east antarctic plateau are covered by snow megadunes: trough-and-crest features that appear to result from vigorous surface-atmosphere interaction. A study of these features will lead to an improved understanding of their formation and characteristics, which may help identify megadune-altered ice in ice cores.

Megadunes today extend over 500,000 square kilometers (km). The climatology of dunefields, characterized by low accumulation and consistent katabatic winds, suggests that they may have been even more extensive in the past. Megadunes have amplitudes of 2 to 5 meters and wavelengths of 2 to 5 kilometers, and are slightly asymmetric, with shorter upwind faces. The crests, up to 100 km long, are perpendicular to local katabatic wind flow. Satellite images show that the dune pattern remains unchanged for decades. Near-zero accumulation rates imply that snow remains near the surface and susceptible to modification for many years, both through surface exposure and subsurface ventilation. We suspect that megadunes are formed by a sublimation/vapor-redeposition process that operates in a standing wave airflow pattern set up over the snow. The climate record eventually preserved beneath dunefields is thus unlikely to represent the regional conditions of deposition, but the degree of modification is unknown.

Over two successive seasons, we will study an area within the large, well-developed megadune field southeast of Vostok Station in East Antarctica. Our objectives are to determine the physical characteristics of the firn across the dunes and to install instruments to measure the time variation of near-surface wind and temperature with depth to test and refine our hypotheses on megadune formation. Field study will consist of surface, snowpit, and shallow core sampling; ground-penetrating-radar profiling; topographic and ice-motion surveys; automatic weather station installation; accumulation/ablation measurements; subsurface temperature; and firn permeability.

We will also continue our remote-sensing study of the dunes across the continent, as well as earlier studies of dune characteristics, and will model diffusion, ventilation, and vapor transport processes within the dune firn as well.

Megadunes are a manifestation of an extreme terrestrial climate (the limit of cold and dry) and may provide insights on past terrestrial climate or processes active on other planets. Megadunes are likely to represent an end-member in firn diagenesis and as such may have much to teach us about the processes involved. (I–186–M; NSF/OPP 01–25570, NSF/OPP 01–25276, NSF/OPP 02–25992, and NSF/OPP 01–25960)

Earth's largest icebergs.
Douglas MacAyeal, University of Chicago; Charles Stearns, University of Wisconsin–Madison; and Emile Okal, Northwestern University.

Icebergs released by the antarctic ice sheet represent the largest movements of fresh water within the natural environment. Several of these icebergs, B–15, C–19, and others calved since 2000, represent over 6,000 cubic kilometers of fresh water—an amount roughly equivalent to 100 years of the flow of the Nile River.

We will study the drift and breakup of the Earth's largest icebergs, which were recently released into the Ross Sea as a result of calving from the Ross Ice Shelf. We will attempt to ascertain the physics of iceberg motion within the dynamic context of ocean currents, winds, and sea ice, which determine the forces that drive iceberg motion, and the relationship between the iceberg and the geographically and topographically determined pinning points on which it can ground. In addition, we will study the processes by which icebergs influence the local environment (sea ice near Antarctica, access to penguin rookeries, air-sea heat exchange and upwelling at iceberg margins, nutrient fluxes), as well as the processes by which icebergs generate globally far-reaching ocean acoustic signals that are detected by seismic-sensing networks.

In addition, we will attempt to deploy automatic weather stations, seismometer arrays, and global positioning system tracking stations on several of the largest icebergs presently adrift, or about to be adrift, in the Ross Sea. Data generated and relayed via satellite to our home institutions will lead to theoretical analysis and computer simulation and will be archived on a Web site *(*http://amrc.ssec.wisc.edu/amrc/iceberg.html*)* that scientists and the general public can access.

A better understanding of the impact of iceberg drift on the environment, and particularly the impact on ocean stratification and mixing, is essential to understanding the abrupt global climate changes witnessed by proxy during the Ice Age and future greenhouse warming. More specifically, the study will generate a knowledge base useful for the better management of antarctic logistical resources that can occasionally be influenced by the adverse effects icebergs have on sea ice (the shipping lanes to McMurdo Station, for example). (I–190–M; NSF/OPP 02–29546, NSF/OPP 02–30028, and NSF/OPP 02–29492)

Dry valleys Late Holocene climate variability.

Karl Kreutz and Paul Mayewski, University of Maine.

We will collect and develop high-resolution ice-core records from the Dry Valleys in southern Victoria Land and provide interpretations of interannual to decadal climate variability during the past 2,000 years (late Holocene). We will test hypotheses related to ocean/atmosphere teleconnections (e.g., El Niño Southern Oscillation, Antarctic Oscillation) that may be responsible for major late Holocene climate events such as the Little Ice Age in the Southern Hemisphere.

Conceptual and quantitative models of these processes in the Dry Valleys during the late Holocene are critical for understanding recent climate changes. We plan to collect intermediate-length ice cores (100 to 200 meters) at four sites along transects in Taylor and Wright Valleys and analyze each core at high resolution for stable isotopes, major ions, and trace elements. A suite of statistical techniques will be applied to the multivariate glaciochemical data set to identify chemical associations and to calibrate the time-series records with available instrumental data.

Broader impacts of the project include

- contributions to several ongoing interdisciplinary antarctic research programs;
- graduate and undergraduate student involvement in field, laboratory, and data interpretation activities;
- use of project data and ideas in several University of Maine courses and outreach activities; and
- data dissemination through peer-reviewed publications, University of Maine and other paleoclimate data archive Web sites, and presentations at national and international meetings. (I–191–M; NSF/OPP 02–28052)

Millennial-scale fluctuations of dry valleys lakes: Implications for regional climate variability and the interhemispheric (a)synchrony of climate change.

Brenda L. Hall, University of Maine, and Glenn Berger, University of Nevada, Desert Research Institute.

What drives glacial cycles? Most researchers agree that Milankovitch seasonal forcing paces the ice ages, but how these changes are leveraged into abrupt global climate change remains unknown. A current popular view is that the climate of Antarctica and the Southern Ocean leads that of the rest of the world by a few thousand years or more. The character of deglaciation in Antarctica is that of a long gradual warming, rather than an abrupt change, although the paleoclimate record is not well defined. The most persistent challenge to the asynchrony hypothesis is the Taylor Dome ice core. Revision to the chronology has shown that the original interpretation of rapid climate change synchronous with deglaciation in Greenland was probably an artifact of very low accumulation rates.

Millennial-scale fluctuations of high-level, closed-basin, amplifier lakes in the dry valleys of Antarctica can shed some light on this issue: some 150 radiocarbon dates of algae from deltas and shorelines record rapid oscillations of these high-elevation lakes that extend through the Holocene. This record has the potential to form an independent data set with which to test the synchrony of abrupt climate changes in Antarctica. However, this approach has several shortcomings, including the fact that the record in the Holocene and earlier is unclear, a lake-level record based on geomorphological features alone is discontinuous, and only levels higher than the present lakes are recorded.

The ideal way to address these problems is to integrate the geomorphological record with a series of cores taken from lake bottoms. Using an approach designed to extract the greatest possible amount of data, we will obtain transects of long cores from Lakes Fryxell, Bonney, Joyce, and Vanda. Estimates of hydrologic changes will come from different proxies. Chronology will come from the dating of carbonates, as well as luminescence sediment dating. Evaluation of the link between lake level and climate will come from modeling.

Combination of the more continuous lake-core sequences with the spatially extensive geomorphological record will result in an integrated data set that extends back at least 30,000 years. This record will be compared with dry valley glacier records and ice cores to address questions of regional climate variability and then with other Southern and Northern Hemisphere records to assess the interhemispheric synchrony or asynchrony of climate change. (I–196–M; NSF/OPP 01–24014 and NSF/OPP 01–24049)

Tidal modulation of ice stream flow.
Sridhar Anandakrishnan, Richard Alley, and Donald Voigt, Pennsylvania State University, and Robert Bindschadler, National Aeronautics and Space Administration/Goddard Space Flight Center.

We will investigate the new-found, startling sensitivity of major west antarctic ice streams to tidal oscillations in order to learn the extent and character of the effect and its ramifications. Ice streams D, C, and Whillans (B) all show strong but distinct tidal signals. The ice plain of Whillans is usually stopped outright, forward motion being limited to two brief periods a day, at high tide and on the falling tide. Motion propagates across the ice plain at seismic wave velocities. Near the mouth of D, tides cause a diurnal variation of about 50 percent in ice-stream speed that propagates upglacier more slowly than on Whillans, and seismic data show that C experiences even slower upglacier propagation of signals. Tidal influences are observed more than 100 kilometers (km) upglacier on C and more than 40 km upglacier on D and may be responsible for fluctuations in basal water pressure reported 400 km upstream on Whillans.

During the first year, five coordinated seismic and global positioning system (GPS) instrument packages placed 100 kilometers apart on each stream will measure Whillans and ice stream D. These packages will be deployed at sites selected by satellite imagery and will operate autonomously for two lunar cycles to study the sensitivity of the streams to spring and neap tides. Also, we will examine existing data sets for clues to the mechanisms involved and develop preliminary models.

During the second and third seasons, we will examine in greater detail the tidal behavior of Whillans and D. We will especially focus on at least one source area for Whillans, assuming that areas inferred from preliminary data remain active. Vertical motions have not yet been detected, but differential GPS will increase sensitivity. Seismic instrumentation will greatly increase temporal resolution and the ability to measure the propagation speed and any spatial heterogeneity.

Improved knowledge of ice-stream behavior will contribute to assessing the potential for rapid ice-sheet change affecting global sea levels. Results will be disseminated through scientific publications and talks at professional meetings, as well as contacts with the press, university classes, visits to schools and community groups, and other activities. (I–205–M; NSF/OPP 02–29629)

Western divide WAISCORES (Western Antarctic Ice Cores) site selection.
Howard B. Conway and Edwin Waddington, University of Washington.

The West Antarctic Ice Cores (WAISCORES) community has identified the western divide, between the Ross embayment and the Amundsen Sea, as the region for the next deep-ice core. The Ice Core Working Group (ICWG) has developed a document titled *WAISCORES: Science and Implementation Plan, 2000* that outlines the objectives of the drilling and the physical and chemical properties the core must have to achieve those objectives.

The divide region spans more than 40,000 square kilometers, and preliminary site selection using airborne geophysical methods is now underway. This work has identified several potential drilling sites where the climate record should be best preserved throughout its long history of ice dynamics. We will make a suite of ground-based geophysical measurements to map spatial variations of iceflow, accumulation rate, internal layering, and ice thickness at two of the most promising sites. Our main investigative tools are high- and low-frequency ice-penetrating radar, repeat global positioning system surveys to calculate the present-day surface velocity field, synthetic aperture radar interferometry to calculate the regional velocity field, and short firn cores to calculate present-day accumulation rates.

Beyond the initial mapping and interpretation of internal layers and surface velocity, the measurements will be used to constrain our iceflow modeling. In particular, we will use these measurements and models to identify the specific site that is most likely to satisfy the following ICWG criteria:

- minimal disturbance from an iceflow,
- a record that extends back at least 50,000 years, and
- countable annual layers back 20,000 years.

A fourth criterion (good preservation of chemical species) will be addressed by others.

The first criterion (minimal disturbances) will be evident from the patterns of radar-detected internal layers. To address the other two, we will use the measurements as input for time-dependent iceflow and temperature models that predict depth variations of age, layer thickness, and temperature. The mismatch between the model predictions and the data eventually recovered from the core will help infer thinning and climate histories for the region, in addition to yielding an estimate of expected conditions before drilling. The information we gather will help guide site selection for drilling. (I–209–M; NSF/OPP 00-87345)

Glacial history of Ridge AB.

Howard Conway, University of Washington.

Scientists do not fully understand how the configuration and activity of the drainage system of the West Antarctic Ice Sheet are changing. For the following reasons, Ridge AB constitutes a key area for studying this issue:

- While previous studies of inter–ice stream ridges in West Antarctica have revealed much about the history of the surrounding ice streams, there remains an information gap in the southern sector of the ice sheet. We believe that a targeted study of Ridge AB will reveal new information about recent changes in the configuration and activity of ice streams A and B.

- Geologic evidence from Reedy Glacier indicates that the ice near Ridge AB was about 700 meters (m) thicker during the last glacial maximum. This helps constrain the magnitude of thinning that has occurred through the Holocene and opens the possibility of linking the history of the West Antarctic Ice Sheet to the geologic record in the Transantarctic Mountains.

We will begin by using high- and low-frequency radar systems, global positioning system surveying methods, and short (20-m) firn cores to map spatial variations of internal layering, buried crevasses, surface velocity, and accumulation rate. We will then put these diagnostic measurements into ice-flow models to infer the glacial history of Ridge AB and the surrounding ice streams. We will interpret this history in the context of the histories that are emerging from the other inter–ice stream ridges, as well as the geologic evidence from Reedy and other outlet glaciers in the Transantarctic Mountains. These explorations and analyses will enhance scientific understanding of the evolution of the drainage system of the West Antarctic Ice Sheet. (I–210–M; NSF/OPP 00–87144)

Glacier change in the southern Indian Ocean: Brown Glacier, Heard Island.

Martin Truffer, University of Alaska–Fairbanks.

Heard Island, which is located in the southern Indian Ocean, is a small (367-square-kilometer) subantarctic island consisting of a 2,700-meter-high composite volcano that is glacierized on all sides. Our intent is to help establish a baseline profile of Heard Island glaciers by measuring some basic glaciological parameters (mass balance, flow velocity, ice thickness) in order to relate the observed changes in the glacier to climate and thus provide an important indicator of climate change in one of the most remote and least visited places on the planet. Specifically, our objective is to determine the current mass balance, geometry, and flow regime of Brown Glacier. Documenting glacier change fills an important gap in the picture of global climate change. Heard Island is one of only a few landmasses at this latitude, and its elevation range makes it a prime candidate for glacier study. It is also a World Heritage site, and it is believed that no human-introduced plant or animal life exists there.

This is a collaborative project with the Australian Antarctic Division (AAD), which will be responsible for logistics and some personnel, and provides an excellent opportunity for U.S. involvement in an area where it would be nearly impossible to operate without local collaboration. The AAD, which has a long history of successful collaboration with U.S. investigators, concentrates its work in and around the eastern part of the continent and therefore complements U.S. work in the western part of Antarctica.

Much of the work is interdisciplinary, such as the study of plant recolonization after glacial retreat, and the field team includes geologists, glaciologists, and plant and wildlife biologists. The results will be published in peer-reviewed journals and will be the subject of lectures to the general public. The work will also be part of a doctoral dissertation at the University of Tasmania in Hobart, Australia, and will thus contribute to the education of a young scientist. (NSF/OPP 03–35936)