ANTARCTIC JOURNAL OF THE UNITED STATES

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In this issue . . .

The R/V *Polar Duke* arrived in Port Fourchon, Louisiana, on 4 June 1997, ending its 13-year mission in support of antarctic research for the National Science Foundation. Antarctic Support Associates, NSF contractor, unloaded supplies and equipment for storage until they are put aboard the *Laurence M. Gould*, a new ship being built by Edison Chouest Offshore for antarctic service.

This issue introduces the monthly online *Antarctic Journal*. The Office of Polar Programs hopes readers will like the increase in frequency from quarterly as well as the shift to online access. The change eliminates the cost of printing and mailing the former quarterly issues, which will no longer be prepared.

This issue is big because it has some of the backlog of a recurring feature, lists of National Science Foundation antarctic awards, that used to be in the printed quarterlies. Another recurring item, monthly weather summaries from U.S. antarctic stations, also will be brought up to date in future issues. After the backlog is gone, the size each month will be about eight pages.

The annual review issue, consisting of articles by investigators about the recent and ongoing research, will continue in both print and online versions.

The *Antarctic Journal* has had several changes since its inauguration in 1966 as a medium for information about, and related to, the U.S. Antarctic Program. The magazine belongs to you, its contributors and readers. As always, NSF will welcome ideas for improvement.

Message from the former Director, Office of Polar Programs:

Looking toward the future

When I accepted the position of director of the National Science Foundation's (NSF) Office of Polar Programs 4 years ago, I described antarctic research as being on the threshold of change—at the beginning of a new age characterized by an awareness of the interdependence of global systems, the need to preserve the continent's unique environment, new research opportunities that could not be conducted elsewhere or could be effectively conducted only in Antarctica, and the importance of cooperation among nations.

The U.S. Antarctic Program was also in transition. Although historically USAP had been a leader in science, policy, logistics capabilities, and advanced technology use, the program faced many new challenges. Questions were raised about the nature of U.S. antarctic policy and activities in the post-Cold-War era. Do Presidential memoranda, articulated in the 1980s apply in the 1990s? Is the quality of research performed in Antarctica up to the standards of research supported by the rest of the NSF? How should the NSF respond to the Navy's stated desire to withdraw from supporting the program? Other challenges appeared in the form of greater competition for funding and of the potential conflicts between our new responsibilities for environmental protection and preservation on one hand and the support and conduct of science on the other. USAP also faced the challenge of repairing and replacing, in a time of constrained budgets, the infrastructure that supports antarctic research.

In this time of transition, two high-level studies of USAP were conducted. The results of both are likely to define the future of U.S. activities in Antarctica. The first, conducted by the National Science and Technology Council (NSTC) at the request of a Senate committee, examined options for reducing operational costs and considered options including increased international cooperation, less than a year-round human presence, and closing stations. The Council, which is chaired by the President, concluded that U.S. national and scientific interests are well served by USAP and emphasized that the United States should maintain an active and influential presence in the Antarctica. The NSTC report notes that the science conducted in Antarctica is of high quality and of interest to a broad scientific community and that often the results of these investigations imply consequences for human activity beyond those usually associated with basic research.

To explore options for sustaining the high level of U.S. antarctic research under constrained funding levels, the NSTC recommended that NSF convene an External Panel. This panel, consisting of 11 distinguished representatives from the research community, the Federal Government, and the business community, received about 70 briefings, conducted 80 meetings with people involved in all aspects of USAP, and inspected McMurdo and Amundsen-Scott South Pole Stations between October 1996 and February 1997. The panel's task was to examine in detail the infrastructure, management, and scientific options for the U.S. presence in Antarctica.

From this investigation, the panel concluded that it agrees with the NSTC that a strong U.S. scientific presence in Antarctica, including three permanent research stations, is essential. In its view, the substantial U.S. presence in Antarctica is a critical element in ensuring the continued political stability of the region. By working with other nations, the United States has a significant role in preserving the antarctic ecological system, an important indicator of global change. The panel supported the opinion of NSF and NSTC that South Pole Station needs to be replaced and that facilities at McMurdo and Palmer Stations need modernization.

The final report of the External Panel, with its 22 principal findings and 12 recommendations, probably will influence how the United States works in Antarctica for many years. The House Committee on Appropriations, after reviewing the panel's findings, recommended full funding for the redevelopment of South Pole Station in its FY98 budget recommendation for NSF. The House and Senate are still completing the budget for FY98.

The endorsements of these two reports have bolstered USAP during a time of change in the way the program is supported and managed. This austral summer, many of you will see that the presence of U.S. Navy is greatly reduced. In its place are contractors, such as PHI Helicopters, and Air National Guard personnel. A new research ship, *Laurence M. Gould*, will make its first voyage to Antarctica, replacing the *Polar Duke*, which served USAP well for nearly 13 years. However, transition may also mean greater competition for a smaller amount of research funds, as NSF works to upgrade the infrastructure of the program.

When I began serving the National Science Foundation, I urged scientists to make a greater effort to explain to the public how polar research relates to their lives. As I return to the academic community, I realize that we must continue in our efforts to make others more aware of the role Antarctica has in global processes and to convey our understanding of the complexity of the processes that drive our environment. By doing this we can establish a dialog that will encourage the exchange of ideas and that will open doors to new forms of cooperation, new research and education opportunities, and the potentials offered by scientific and technological advances in the interests of our society.

Cornelius Sullivan ends term at NSF

On 31 July 1997, after more than 4 years of service, ***Cornelius W. Sullivan****, Director of the Office of Polar Programs, left the National Science Foundation (NSF) to assume new responsibilities as Vice Provost for Research at the University of Southern California. An oceanographer whose research focuses on the structure and function of ice-covered marine ecosystems, Dr. Sullivan joined NSF's Office of Polar Programs as Director in 1993. Before coming to the Foundation, Dr. Sullivan was Director of the Hancock Institute of Marine Studies and directed the graduate program in Ocean Sciences at the University of Southern California, as well as serving as professor in the University's Department of Biological Sciences. He also has been a visiting professor at the University of Colorado, the Massachusetts Institute of Technology, the U.S. Army's Cold Regions Research and Engineering Laboratory, and NASA's Goddard Space Flight Center. He earned his doctorate degree in marine biology from Scripps Institution of Oceanography, University of California–San Diego. His master of science degree in microbiology and his bachelor of science degree in biochemistry were from Pennsylvania State University.*

NSF's plans for a successor to Dr. Sullivan have been announced.
http://www.nsf.gov/od/lpa/news/press/pa971.htm

Dr. Sullivan may be reached at the University of Southern California at the following address, telephone or fax numbers, or e-mail address:

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Submitting manuscripts to the *Antarctic Journal*

The *Antarctic Journal of the United States* invites contributions from members of the antarctic science, logistics, and policy communities who want to communicate their work and ideas to an audience that combines specialists and scientifically literate non-specialists. The *Antarctic Journal* is not peer reviewed but rather provides reports on U.S. activities in Antarctica and related activities elsewhere and on trends in the U.S. Antarctic Program. For additional information, contact **Winifred Reuning, Editor *Antarctic Journal*; National Science Foundation; Office of Polar Programs; Room 755; 4201 Wilson Boulevard; Arlington, VA 22230; phone: (703) 306-1033; Internet: wreuning@nsf.gov.**

- ***Submitting material for the monthly online issues***
- ***Submitting articles to the annual review issue***

Submitting material for the monthly online issues of *Antarctic Journal of the United States*

The editor of the *Antarctic Journal* will consider unsolicited manuscripts for publication. Format and content requirements for articles are summarized below; however, interested authors should review previous issues for style and content or contact the editor directly.

The audience for the monthly online issues is broad in background and interests, so authors should make sure that their articles will be intelligible to readers outside of their scientific discipline or other area of expertise. Avoid specialized jargon and abbreviations, but use technical terms as necessary. Define terms likely to be known only by readers who are familiar with subject. Spell out acronyms when they first appear, including standard scientific terms and chemical abbreviations, as well as names of organizations.

Papers will be edited to improve style, clarity, and grammar. Authors will have the opportunity to review their edited manuscripts before publication.

Articles: Feature articles should be no longer than 1,500–2,500 words, but there is no limit on the number of illustrations (figures, tables, or photographs). Appropriate topics include recent or significant science discoveries or advancements, cold-regions engineering, special support activities or issues, history, environmental topics, and policy issues.

Notes: Shorter articles, 800–1,000 words, will also be considered. Illustrations may be submitted with these articles, but notes should not include more than five figures. Appropriate topics for notes include meeting reports or announcements, new or improved technology, polar publications, and support or related activities.

Submitting articles to the annual review issue of *Antarctic Journal of the United States*

A summary of AJUS requirements

- **Keep your article within the word limit**. Articles must be no more than 1,300 words, *including* figure captions and reference lists.

- **Write with *Journal* readers in mind.** *Antarctic Journal*'s readers are primarily people outside your field of specialization. Our audience is diverse and international. Describe the progress of your research in such a way that readers with a college degree, but not necessarily a science degree, will understand the significance of what you do.

- **Keep in mind that *Antarctic Journal* is not refereed.** Although the National Science Foundation copyedits submissions, articles are *not* peer-reviewed for scientific content or merit. Your writing objective for this publication is to *summarize* your research, not to present it in detail for replication or scientific review by others.

- **Follow *Journal* style—**
  - List no more than three authors.
  - Double space *everything*.
  - Spell out ALL abbreviations and acronyms at first use.
  - Use metric for all measurements.
  - Check your reference list to make sure it's complete and correct.

- **Keep artwork as simple as possible—**
  - Use no more than three pieces of artwork.
  - Send camera-ready artwork, not computer files.
  - Submit only black-and-white artwork.
  - Avoid screens (shading) produced by the computer in your artwork.
  - Send glossy prints of photos. If you are submitting digitized images, please contact the editor first for format information.
  - Type the captions with the text, not on the artwork.

Questions about writing style and manuscript preparation

Who will read my Antarctic Journal article? Make sure the significance of your work will be apparent to readers ***outside*** your field, even if you feel you are explaining too much for your own colleagues. Readers of the *Journal* include the multidisciplinary and international community of antarctic researchers, antarctic program managers, government officials, and the public. Avoid specialized jargon and abbreviations, but use technical terms as necessary. Define terms likely to be known only in your field. Do not use the

IMRAD style (i.e., introduction, methods, results, analysis, and discussion) of presentation; take a less formal approach.

Why is sticking to the word limit so important? Articles must not exceed 1,300 words, including the figure captions and reference list, and they must have no more than three figures and no more than three tables. Over the years, the *Journal* has grown both in the number of articles received and in the length of each article. To be able to publish as many articles as possible, it has become necessary to enforce the word limit. If we don't limit the number of pages, the book will become too large to bind and too expensive to mail. What's more, as articles become longer, they also tend to become too technical for the *Journal*'s multidisciplinary and nonscience reading audiences.

What style guide should I follow? The *Journal* follows the *Government Printing Office Style Manual* (1984 edition) and *The Chicago Manual of Style* (14th edition).

How should I handle abbreviations? Define all symbols and spell out all acronyms and abbreviations where they first appear, even terms that are common in your discipline, including scientific acronyms, standard scientific notation, measurements, and chemical abbreviations, as well as names of organizations. Don't use any abbreviations on your artwork that you haven't defined in text. Please use metric for all measurements.

Who is considered an "author"? List as authors only those who actually participated in writing the paper; please limit this list to three authors. Cite other project participants in the acknowledgments. Please include the complete address (institution, city, state, and ZIP code) for all authors.

Is double spacing really necessary, even on the reference list? Absolutely. Use double-spacing for *all* parts of your manuscript—for tables, references, and figure captions as well as text.

May I submit an electronic version? Electronic submissions are preferred, but please send a hard copy as well and make sure that symbols, characters, accents, and other similar items are correct on the hard copy. All electronic submissions must be IBM compatible. Use a 3.5-inch disk and WordPerfect, Microsoft Word for Windows, or ASCII format. Disks will not be returned. If you want to submit a manuscript by electronic mail, please contact the NSF editor first.

How many copies of my article should I submit? Please send two copies of each submission, one with original artwork and one with photocopies.

What's the purpose of the "Manuscript Cover Sheet"? The names and addresses you supply on this sheet tell us where to send the edited manuscript for author review. The travel dates you provide help us know when you will be unavailable. If you are submitting more than one manuscript, please include a cover sheet for each manuscript. If you are a project leader and want to have papers organized in a specific order, please include this information in the cover letter that accompanies your manuscripts.

What happens to my paper after submission? Papers are edited to ensure that they conform to *Journal* style, that they are clear and understandable for the intended audience, that they are internally consistent, and that they are free of grammatical, spelling, and punctuation errors. Authors receive their edited manuscripts for review.

Artwork

Printable artwork. Provide hard-copy, camera-ready illustrations of each figure. The annual review issue is printed traditionally, so we can't use computer file copies, art with computer-generated grayscale, or color line art. Line art should be composed using only solid black lines, open white spacing, and cross-hatching or stippling. Scanned and color photos reproduce poorly, so please submit only glossy-finish, black-and-white photos. (Some digitized images are acceptable, but please check with the NSF editor first.) A sharp image with good contrast is essential for quality reproduction, so photocopies in place of originals can't be accepted.

Type size. Remember that illustrations may be reduced by 50 percent or more. Make sure that all text and numbers on the illustration will be legible if reduced.

Combined art. To help decrease production time and costs, please combine separate parts of the same figure (i.e., "*A*," "*B*," and "*C*") into a single piece of artwork and label each part with a capital, italicized letter.

Labeling. Line art should be labeled in a margin on the front. Photographs should be labeled on the back. To avoid marring the image, an Avery-type label may be used. All figure labels should include the figure number and the lead author's last name and initials. If a lead author has submitted more than one article, include enough words from the title to distinguish it from other submissions. If you want your illustrations returned, please indicate this on the art itself and include the name and address of the person to whom it should be returned.

Captions. Captions for all figures should be double-spaced and should follow the reference list with the *text* of the manuscript. Do not type the captions on the artwork. Please remember to cite figures in the text. If you have more than one figure, each must have a separate number. Include credit information, if applicable, in the caption.

Tables

Remember to include titles and in-text citations for all tables. Don't forget to spell out any abbreviations that you haven't defined in the text. Keep your tables simple, direct, and easy to grasp. Use no more than three tables per article, regardless of the size of the tables.

References

Format. The basic reference format for the *Antarctic Journal* is

> First author (last name, initials), Second author (initials last name),... and Last author (initials last name). Year of publication. Title in sentence style (no quotation marks). Editors (of book). Full title of journal or book. Either journal information (volume, number, page numbers) or book information (location and name of publisher).

For references with more than one author, please cite all authors (do not use "et al."). If you're unsure of the format for a particular entry, refer to past issues of the *Antarctic Journal*. List only the references you cited in text on your reference list.

Journals. Spell out titles of all journals and give both volume and issue number. (Issue numbers may be omitted only for publications paginated consecutively throughout a volume.)

Books and proceedings. Be sure to cite the city and state or country of publication for books. Do not include the page numbers. Provide the date of conferences and the name and location of the publisher of the proceedings.

Foreign language. For articles or books published in a foreign language, please provide a translated title along with the original title.

Text citations. For citations with one to three authors, include the last name(s) and the year of publication. When more than three authors are cited, use the first author's name, "et al.," and the year of publication. All authors and publications you cite in text must be included on your reference list.

Abstracts

Because the Library of Congress *Antarctic Bibliography* will be citing your work, you may want to submit a 100-word abstract of your paper for use by this abstracting and indexing service. These abstracts will not be used in the *Antarctic Journal*, so please submit them on a separate sheet of paper and include the article's title and authors' names.

Handling AJUS-specific information

Field research sites. If you don't use an index map, cite geographic coordinates of study areas. Avoid use of unofficial names. For official antarctic names, refer to *Geographic Names of the Antarctic*, U.S. Board on Geographic Names, (NSF 95-157) or the *Gazetteer of the Antarctic*, National Science Foundation, 1989.

Personnel. List all field personnel, and give the dates that they were in the field. Use names, not initials.

Grant numbers. If appropriate, use this sentence as your last paragraph: "This research was supported by National Science Foundation grant [contract]…" (Insert your grant or contract number in the blank space.) Make sure that you include your complete, seven-digit grant or contract number (not your "S" number) as well as the full name of the granting agency.

Cover photographs or illustrations. Particularly good photographs or drawings will be considered for use on the cover. Please provide caption information and a credit line for all potential cover photographs.

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Do you have questions about submitting your work to AJUS?

Contact the *Journal* editor: Winifred Reuning, Polar Coordination and Information Section, Office of Polar Programs, National Science Foundation, 4201 Wilson Boulevard, Arlington, VA 22230; phone: (703) 306-1033; fax: (703) 306-0139; e-mail: wreuning@nsf.gov.

Current Antarctic Literature

Current Antarctic Literature, regarded as the world's most comprehensive antarctic abstracting and indexing service, is the monthly awareness service of the *Antarctic Bibliography*. As of 1 January 1997, it is no longer available as a printed publication. The complete *Antarctic Bibliography* file, which extends back to 1951, will be available for online searching on the Library of Congress Project World Wide Web site in 1997.

Uncopyrighted items cited in *Current Antarctic Literature* are available from the Library of Congress, Photoduplication Service, Washington, DC 20540.

The Office of Polar Programs, National Science Foundation, sponsors *Current Antarctic Literature* as part of the Cold Regions Bibliography Project, Science and Technology Division, Library of Congress, which enjoys substantial collaboration with Scott Polar Research Institute, Cambridge, England. Comments may be sent to the project (**crbp@loc.gov**) or the sponsor (**gguthrid@nsf.gov**).

Suggestions for items to be cited are welcome (**crbp@loc.gov**). Please include complete bibliographic information. Suggested items should be consistent with the project's Sponsor Interest Profiles and Selection Criteria, on the Cold Regions Bibliography Project home page. For the Antarctic, NSF's interests are geographic (limited to the antarctic region) but cover all science disciplines.

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Last modification: 11 July 1997 (ers)

For bibliographic citations and abstracts see:
http://www.crrel.usace.army.mil/library/aware/antlit.htm

Highlights of the August 1997 Current Antarctic Literature

The Library of Congress compiles the monthly *Current Antarctic Literature* (online only) and the annual *Antarctic Bibliography* with funding support from the National Science Foundation. Scott Polar Research Institute, Cambridge, England, collaborates with the Library in this project.

News from "The Ice" and beyond

New evidence points to impact of high ultraviolet radiation levels

Antifreeze gene in polar fish demonstrates convergent evolution

Glaciologists process ice cores from Siple Dome, West Antarctica

Long-time researcher spots a rare white emperor penguin

Satellite data confirm existence of hypothetical "Bellingshausen plate"

ASA employee Charles Gallagher dies at McMurdo Station

New evidence points to impact of high ultraviolet radiation levels

Biologists from Northeastern University and the University of Texas report the first direct evidence that increased levels of ultraviolet-B (UVB) radiation, caused by the depletion of ozone over Antarctica and its surrounding oceans each autumn, have a destructive effect on the natural animal populations in the area. An article published in the 17 February 1997 issue of the *Proceedings of the National Academy of Sciences* (http://www.pnas.org/) details findings of DNA damage to the eggs and larvae of a hemoglobinless antarctic icefish—damage that coincides with the increased intensity of UVB in the study area around the Antarctic Peninsula. "Ozone depletion has previously been shown to harm one-celled marine plants in Antarctica," observed William Detrich, one of the authors of the study. "We've now documented significant damage at a higher level of the food chain." The researchers speculate that the excess UVB radiation may slow a fish's growth, hamper its cellular processes such as transcription and mitosis, and divert its store of energy to DNA repair. Ultimately, these biologists believe, the damage done by increased UVB levels may mean that fewer eggs and larvae survive to adulthood. For more information, see also http://www.nsf.gov/od/lpa/news/press/pr9719.htm and http://sciencenow.sciencemag.org/archives.297.shtml (Friday, 21 February 1997).

Aboard the National Science Foundation research vessel *Nathaniel B. Palmer*, other researchers have discovered that algae in the Weddell Sea are extremely sensitive to the annual increases in UVB. Patrick Neale, a biologist from the Smithsonian Institution's Environmental Research Center, found that UVB exposure led to a greater reduction in photosynthesis in Weddell Sea algae than in algae from the Chesapeake Bay and other marine waters. Reasons for this hypersensitivity in polar algae are unknown and will be the focus of Neale's follow-up studies in 1997 and 1998. (http://www.nsf.gov/od/lpa/news/tips/tip70527.htm#second)

The protective ozone layer over Antarctica has thinned each autumn for the past two decades as human-created chemicals called chlorofluorocarbons (or CFCs) have risen to the stratosphere and played a part in the destruction of ozone. The release of CFCs into the atmosphere has now been limited by an international treaty, but pre-treaty CFCs, still circulating in the atmosphere, are expected to deplete the ozone for decades to come. In fact, some scientists believe that the ozone depletions will spread over more of the globe before they begin to decrease in the next century.

Antifreeze gene in polar fish demonstrates convergent evolution

New research shows that notothenioid fish from the southern oceans around Antarctica and Arctic cod from the other end of the globe each developed, independently of the other, an antifreeze glycoprotein (AFGP) to keep their blood and organs from freezing as global temperatures began to cool. Research by three University of Illinois biologists, Arthur L. DeVries, Liangbiao Chen, and Chi-Hing C. Cheng, traces for the first time the genetic process by which a novel protein evolved and adapted to environmental change.

DeVries first discovered AFGP in antarctic icefish in the 1960s, and when a similar substance was found in Arctic cod, biologists speculated that the two species had somehow shared a common ancestry. DeVries's recent work, however, demonstrates that although the AFGP in the Arctic cod is nearly identical to that in the notothenioids, the gene that codes for it isn't, proving that the two AFGPs developed independently. DeVries, Chen, and Cheng located the parent gene, a digestive enzyme called *trypsinogen*, for the AFGP in the antarctic species and then determined that the AFGP gene for the antarctic species differs very little (only 4 to 7 percent) from this parent gene. For comparison, the researchers sequenced and analyzed the Arctic cod's AFGP gene and found that it does not resemble the gene for trypsinogen and that it differs from its southern counterpart in gene structure and coding as well.

The AFGP in the antarctic notothenioids, which constitute the majority of fishes in the southern oceans, appears to have developed between 5 million and 14 million years ago, when the southern oceans first began to freeze. Formation of the AFGP allowed the icefish to adapt to the cooling climate by preventing ice crystals from forming in their tissues and allowing them to exploit the newly evolving ecological niche.

The two articles ("Evolution of antifreeze glycoprotein gene from a trypsinogen gene in Antarctic nototheniod fish" and "Convergent evolution of antifreeze glycoproteins in Antarctic nototheniod fish and Arctic cod") describing this work in detail are available online in the April 1997 issue of the *Proceedings of the National Academy of Sciences* at http://www.pnas.org/. See also
http://www.nsf.gov/od/lpa/news/press/pr9729.htm
http://sciencenow.sciencemag.org/archives.497.shtml (Monday, 14 April 1997)
http://www.oc.uiuc.edu/NB/97.05/9705fishtip.html

Glaciologists process ice cores from Siple Dome, West Antarctica

During the 1996–1997 austral summer, 10 individual ice cores, constituting about 700 meters, were drilled near Siple Dome, Antarctica, and shipped to the U.S. National Ice Core Laboratory (NICL) at the U.S. Geological Survey in Denver. During June and July at NICL, the cores were processed and analyzed by 10 to 12 principal investigators and students from universities and laboratories around the United States.

Ice cores contain a wealth of information about past climate and help scientists predict future changes. As snow falls, it traps samples of the cloud water, atmospheric gases, and dust and carries them to the ground. Over time, the fallen snow accumulates into an ice sheet, which can be several kilometers thick and can contain ice that fell as snow over 100,000 years ago. By analyzing the ice, glaciologists can plot a climate history containing, among other measures,

- temperature,
- snow accumulation rate,
- relative wind speeds,
- the occurrence of volcanic eruptions anywhere on the globe,
- general ocean and atmospheric circulation patterns, and
- concentration of carbon dioxide and other greenhouse gases.

Understanding the natural changes to Earth's climate helps scientists determine human influence on climate change.

In the Siple Dome area of Antarctica, glaciologists are analyzing cores from two distinct areas, one far inland and one near the coast. Comparing the ice record from the two regions should help glaciologists understand more fully

- the relationship between atmospheric carbon dioxide and temperature,
- the influence of the west antarctic ice sheet on sea level and the likelihood for unexpected rapid changes in sea level,
- the influence of southern ocean and atmospheric circulation patterns on climate, and
- the cause of changes in the southern ocean and atmospheric circulation patterns.

For more information, see http://www.usgs.gov/public/press/public_affairs/press_releases/pr272m.html and http://www.maxey.dri.edu/WRC/waiscores/.

Long-time researcher spots a rare white emperor penguin

Gerald Kooyman, a biologist from the University of California–San Diego's Scripps Institution of Oceanography has studied penguins in Antarctica for over 30 years, but the austral winter of 1997 brought a surprise: he reported what is believed to be the first sighting of an all-white emperor penguin.

Kooyman was conducting a census of a colony of penguins on the snow-covered sea ice in the western Ross Sea when he spotted the unusual bird. Because its white feathers caused it to blend in with the background, he almost missed it. "There are thousands of penguins in the colony, and they are quite spread out," Kooyman recalled, "but we were counting every chick and that's how we spotted it." Normally, emperor chicks are covered in a grayish down coat and their wing and tail feathers are dark as are their bills and feet. Usually, they have dark rings around their eyes. The chick Kooyman spotted was completely white. "It was really a spectacular bird," he said. Because it didn't have the characteristic red eyes, the white chick is not believed to be an albino. A photo of the rare white bird can be found on the Web at http://sio.ucsd.edu/supp_groups/siocomm/pressreleases/WhitePenguin.html.

Kooyman believed that the chick fledged, and thus, he does not expect it to return to the colony for 4 or 5 years. "The survival rate of the birds from the time they leave the colony until they return is quite low," Kooyman commented. "So the chance of seeing the penguin again is really pretty low."

Satellite data confirm existence of hypothetical "Bellingshausen plate"

Scientists have long known that the topography of the ocean floor and variations in rock density cause minute changes in the strength of gravity in undersea regions. By measuring these marine gravity anomalies, scientists have been able to map the ocean floor and decipher the ancient movement of the tectonic plates that form the Earth's crust. When it came to mapping the ocean floor in the polar regions, however, the seasonal pack ice as well as the permanent ice cover in some areas made the ocean water opaque to all types of electromagnetic wave used to detect marine gravity anomalies elsewhere on the globe. As a result, whole sections of the sea floor, some the size of the United Kingdom, have gone unsurveyed, and in some areas, less has been known about the ocean floor than is known about the surface of Mars or the Moon—until recently.

British scientist Seymour Laxon of the Mullard Space Science Laboratory in Surrey, England, and U.S. scientist David McAdoo of the National Oceanic and Atmospheric Administration have developed a technique to analyze satellite data and retrieve accurate topographic measurements even when sea ice is present. In the 25 April 1997 issue of *Science*, Laxon and McAdoo describe what they uncovered when they applied this technique in the southern oceans and the Arctic Ocean (http://msslsp.mssl.ucl.ac.uk/people/swl/esa97/index.html).

Tectonic plate movement in the south polar region has been a mystery. Some scientists held to the hypothesis that in the earliest stages of the breakup of the ancient supercontinent of Gondwanaland, two plates, rather than just one, represented what is now the continent of Antarctica. About 65 million years ago, the two plates fused into the current "Antarctic plate." The now-missing tectonic plate, revealed by a mismatch of geological data between findings from the Campbell plate which became New Zealand and the Antarctic plate, was named the "Bellingshausen plate" and remained just a hypothesis in the absence of good sea floor data. Using their new technique, Laxon and McAdoo have reanalyzed satellite data from the southern ocean floor and conclude that the Bellingshausen plate did, in fact, exist after the breakup of Gondwanaland and was the long-hypothesized missing piece in the puzzle of ancient continent formation. For more information, see http://msslsp.mssl.ucl.ac.uk/people/swl/grav_background/how.html, http://ibis.grdl.noaa.gov/SAT/curr_res/polar.html, http://msslsp.mssl.ucl.ac.uk:80/people/swl/polar-gravity.html, and http://www.ngdc.noaa.gov/mgg/announcements/announce_predict.html.

ASA employee Charles Gallagher dies at McMurdo Station

On 1 May 1997, Charles (Chuck) Gallagher, 50, died of heart failure following a brief bout of pneumonia, dehydration, and fluid build up around the heart. At the time of his death, plans were underway for the U.S. Air Force to transport him to a medical facility in New Zealand, a 9-hour flight from McMurdo. Gallagher, a U.S. Navy retiree, was an employee of Antarctic Support Associates of Englewood, Colorado, the civilian company that provides support for U.S. science bases in Antarctica. He was in charge of recreational activities for the 155 military and civilian personnel spending the winter at McMurdo Station. His home was in Denver.

Gallagher, who like all winter-over personnel had passed a thorough physical exam before deployment, became ill in late April, just about the time the sun sets for the last time, marking the start of the winter darkness. Winter conditions are so dangerous in Antarctica that flights in and out are suspended from February until supplies are air-dropped during August. Regular flights are not resumed until October. The decision to evacuate Gallagher was made on 28 April when staff at McMurdo determined that Gallagher's unexpected illness required treatment beyond the capabilities of the station's medical facilities. The ice runway had been prepared, and all members of the McMurdo community, as well as those from New Zealand's nearby Scott Base, stood ready to help.

After Gallagher's death, the U.S. Air Force flew a C-141 into McMurdo Station on 8 May to retrieve his remains. The National Science Foundation (NSF) released statements lauding Gallagher's work and expressing sympathy to his family, friends, and colleagues. Dr. Neal Lane, NSF Director, remarked, "Antarctica is often called 'the last frontier.' If that is so, then Chuck was a true frontiersman." Dr. Lane praised Gallagher for "his life of courage, adventure, and exploration" and expressed gratitude for his years of service. (See also http://www.nsf.gov/od/lpa/news/media/nl5197.htm and http://www.nsf.gov/od/lpa/news/press/pr9733.htm.)

NSF External Panel supports replacing Amundsen-Scott South Pole Station

Background

External Panel findings

Related budget information

On 12 March 1997, Norman R. Augustine, Chairman of the U.S. Antarctic Program External Panel, presented to House Committee on Science 22 findings and 12 recommendations (http://www.nsf.gov/od/lpa/congress/anta3-97.htm) that resulted from the panel's 9-month examination of infrastructure, management, and scientific options. Their findings and recommendations were developed to maintain a high-quality research program and implement U.S. policy to provide an active and influential presence in Antarctica, while operating within a realistic budget. The panel's review, the results of which are published in *The United States in Antarctica—Report of the U.S. Antarctic Program External Panel* (April 1997) (http://www.nsf.gov/cgi-bin/getpub?antpanel), emphasized the high geopolitical, scientific, and environmental value of the antarctic program.

Background

The United States has continuously supported antarctic projects for over 40 years. A part of this effort, the U.S. Antarctic Program (USAP) has three principal objectives: presence, science, and stewardship. The stated U.S. policy toward Antarctica is that the continent should be maintained as a peaceful territory, free of national claims disputes and available for the benefit of all humankind. Although the Antarctic Treaty system has created a political environment that today is largely characterized by cooperation and mutual understanding, seven nations have made claims to parts of Antarctica, some overlapping, and potential disagreements remain an underlying reality.

In April 1996, the National Science and Technology Council (NSTC) completed a review of U.S. antarctic policy (http://www.nsf.gov/od/opp/antarct/antprog/start.htm), requested by Senate Appropriations Committee on the Veterans Administration, Housing and Urban Development, and Independent Agencies. The Committee, aware that the National Science Foundation was considering a South Pole redevelopment project, asked the NSTC to examine the policy contained in Presidential Memorandum 6646 (1985), particularly ". . . the need for a year-round presence, the need for three stations, and the roles of NSF, the Department of Defense, and other Government agencies." The Committee asked that the NSTC consider U.S. antarctic policy in the context of the value of science performed, the affordability of a continued U.S. presence, and options for reducing the annual logistics and operational budget.

In its report to Congress, NSTC's Committee on Fundamental Science stated that

> . . . from a Policy perspective . . .maintaining an active and influential presence in Antarctica, including year-round operation of the South Pole Station, is essential to U.S. interests.
>
> . . . the National Science Foundation has implemented U.S. policy in an effective manner, especially by substantially improving environmental stewardship, broadening the science program, and privatizing some operation elements of the Program to reduce costs.
>
> . . . the USAP . . . research program is of very high quality and of great interest to a broad scientific community.

> . . . at the current level of investment, the USAP is cost effective in advancing American scientific and geopolitical objectives, and from a science perspective, [should] support the continuation of three stations with year-round presence.
>
> . . . USAP should give highest priority to correcting critical health, safety, and environmental issues at the current [South Pole] Station.

The Committee also recommended that NSF convene an external panel to "explore options for sustaining the high level of USAP science activity under realistic constrained funding levels."

In response to this final recommendation, Dr. Neal Lane, Director of NSF, established the U.S. Antarctic Program External Panel on 16 August 1996. The charge given the 11-member panel (http://www.nsf.gov/cgi-bin/getpub?antpanel) by Dr. Lane was to "examine and make recommendations concerning the stations and logistics systems that support the science while maintaining appropriate environmental, safety, and health standards; the efficiency and appropriateness of the management of these support systems; and how and at what level the science programs are implemented." The panel members were also asked to consider the eventual replacement of Amundsen–Scott South Pole Station and other USAP infrastructure.

External Panel findings

In his 12 March testimony to House Committee on Science, Mr. Augustine summarized the External Panel's recommendations and answered questions, most of which centered on the ability of the private sector to capitalize on their contributions to antarctic research.

The panel offered a series of 12 specific recommendations (http://www.nsf.gov/od/lpa/congress/anta3-97.htm), each of which is discussed in its report and all of which are included in appendix IV of the report. Overall, the panel concluded that the geopolitical importance assigned to a permanent U.S. presence in Antarctica, particularly at the South Pole, is warranted and that this justifies a year-round presence at several locations, including the South Pole. The panel also emphasized that, by working in cooperation with many nations, the United States is playing an important role in preserving a fragile and nearly pristine ecological system that serves as an indicator of potential global environmental trends. The panel endorsed the NSTC's evaluation that the research being performed in Antarctica is of the same high quality and relevance as that being supported elsewhere by the NSF and that it uses the unique antarctic environment well and addresses significant scientific issues that have important human consequences. On behalf of the panel, Mr. Augustine commended the NSF's management of the logistical and research programs.

Because of the unique physical conditions in Antarctica, the continent is a one-of-a-kind scientific laboratory that enables scientists to investigate phenomena ranging from the microscopic to the Earth-shaping. Changing circumstances, however, particularly federal funding pressures, have resulted in a major realignment of support functions in the Antarctic, including the withdrawal of the U.S. Navy. The Navy had been involved in early exploration and, since the 1950s, research support. As the Navy withdraws, the Department of Defense has been shifting air transport functions provided by ski-equipped Hercules airplanes to the Air National Guard, and NSF has transferred other functions to civilian contractors. As a result, this period is particularly significant, not only in terms of the need for intense management attention but also as an opportunity to search for new ways of reducing costs and of conducting research and related activities.

Because of the NSF's traditional focus on the conduct of science and because of the character of the federal budgeting process, which, unlike commercial practice, does not ordinarily include a depreciation account to provide for the renewal of fixed assets, aging U.S. antarctic facilities are costly to maintain and, in some cases, of arguable safety. In the panel's opinion, the United States would not send a ship to sea or a spacecraft to orbit in the condition of many facilities in Antarctica, especially those at the South Pole. Consequently, they agreed with NSF that steps need to be taken without delay to remedy the existing conditions, particularly of Amundsen–Scott South Pole Station.

NSF has estimated that constructing a replacement station at the South Pole would cost between $150 million and $200 million and that the process would take about 5 years to budget and 8 years to build. After reviewing the design currently being considered by NSF, the panel recommended that the replacement station be reduced in size and cost. They also felt that additional savings must be generated in USAP to offset a substantial fraction of the cost of a replacement facility.

Its principal conclusion is that the South Pole Station needs to be replaced soon for economic, safety, and operational reasons and that modest upgrades are needed at Palmer and McMurdo Stations. Although NSF will correct urgent safety shortcomings at South Pole Station using $25 million funded during FY97, the panel recommended that the other renovations (a minimum of $15 million at Palmer and McMurdo Stations) and the replacement of South Pole Station be funded by a downsizing of the proposed new South Pole Station design, reducing the cost to $125 million excluding $5 million of interim expenses to keep the existing station functional until replacement.

The panel also concluded that a cumulative reallocation of $20 million from science grants and science support between FY98 and FY02 and the generation of at least $30 million in savings through cost-reduction actions already underway would offset costs proposed for infrastructure improvements. Although this represents a considerable reduction in new funding needs relative to previous estimates, it still produces a cumulative shortfall of $95 million over the 5 years during which the replacement South Pole Station is to be funded. It is the conclusion of the panel that these residual funds are not to be found within the resources of the USAP without severely undermining the viability of the science program and degrading health and safety conditions. Consequently, the panel "...recommend[ed] that additional funds in the amount of $95 million should be added to the NSF budget" over the next 5 fiscal years (1998 to 2002) "to permit the phased replacement of the existing South Pole Station." (*The United States in Antarctica: Report of the U.S. Antarctic Program External Panel*, p. 71.)

Related budget information

For more on FY98 Congressional budget actions, see Recent Congressional actions related to the NSF FY98 budget.
http://www.nsf.gov/od/lpa/congress/lanestmt.htm
http://www.nsf.gov/od/lpa/congress/august.htm
http://www.house.gov/science/sensenbrenner_3-12a.html

Recent Congressional actions related to the NSF FY98 budget

The U.S. Antarctic Program External Panel published its report in April 1997, and its influence on U.S. antarctic policy is already apparent in Congressional actions related to the National Science Foundation (NSF) budget.

In the House Committee on Appropriations, the committee members, after reviewing the External Panel report, endorsed the conclusions reached by the panel and agreed with the principal recommendations. The Committee decided, however, that full funding for the Amundsen–Scott South Pole Station replacement and other improvements in Antarctica, rather than incremental funding, would lead to more efficient management of the refurbishment efforts. In the House version of the FY98 Veterans Administration (VA), Housing and Urban Development (HUD), and Independent Agencies Appropriations bill, which includes NSF's budget, $115 million was recommended for construction and refurbishment of facilities in Antarctica. When combined with program savings from logistics operations over the next 5 years, this amount will result in total funding of $145 million available for replacing the existing South Pole Station and infrastructure improvements at McMurdo and Palmer Stations.

On the other hand, in their mark-up of the budget, the Senate VA, HUD, and Independent Agencies Appropriations committee members supported the External Panel recommendation to use the scaled-down version of a new station at the South Pole. Their FY98 budget backed the panel's recommendation that $25 million from this account be used to begin work on the replacement station. The committee also stated its intention to provide $90 million in additional funding over the next 4 fiscal years to complete the replacement station at the South Pole.

Final decision on funding will be made during the conference meeting between House and Senate representatives when Congress resumes its deliberations in September.

For the NSF budget request, see http://www.nsf.gov/bfa/bud/fy1998; for an NSF summary of House and Senate appropriations, see http://www.nsf.gov/od/lpa/congress/105updat.htm; and for an NSF fact sheet, see http://www.nsf.gov/od/lpa/news/media/fsfacil.htm.

R/V *Polar Duke* ends 13 years of service to antarctic science

Leaving Antarctica

University of West Florida biologist Wade Jeffrey, who had the distinction of being the last scientist to conduct research aboard *Polar Duke*—and the only scientist to sample tropical waters from the *Duke*'s deck—spoke for all who ever had worked aboard the research vessel when he bid the ship and crew farewell in June 1997:

> On behalf of all the *Polar Duke* "Party Managers" who have come before me, I wish to extend a deep and sincere thanks to the Captains and crews of the *Polar Duke*. Their hard work, dedication, professionalism, and pride in their work has allowed many of the scientific contributions made aboard the *Polar Duke* to happen.…We will miss the *Polar Duke*.

According to David Karl, a University of Hawaii oceanographer who composed a farewell tribute to the research ship (http://hahana.soest.hawaii.edu/pduke/polarduke.html), the fact that *Polar Duke* was involved in research even as it was sailing from Punta Arenas, Chile, to Port Fourchon, Louisiana, to end its antarctic mission demonstrates the vessel's commitment to the principle of "science first." *Polar Duke*'s swan song found the *Duke* supporting research that asked the question: since ultraviolet levels in antarctic waters are one-tenth that of the levels along the southern coast of the United States, are microorganisms living in low-light environments more sensitive to ultraviolet radiation that those living in high-light latitudes? Jeffrey and his team collected surface-water samples each day of the *Duke*'s 22-day voyage north to determine relative sensitivity of marine phytoplankton, bacteria, and viruses.

The Polar Duke's proud history

Designed and built for research and supply work in the north polar seas, R/V *Polar Duke* was christened in Kyrksæterøra, Norway, in 1983 by Rieber Shipping A/S of Bergen, Norway. When North Sea oil exploration waned, Rieber chartered the ice-strengthened ship to the National Science Foundation (NSF) for antarctic research and support work. In January 1985, the *Duke* replaced the R/V *Hero*, which was retired after 20 years of service. The *Duke*'s initial 3-year charter agreement placed a Canadian crew and flag on the ship, but in 1989, the ship was reflagged Norwegian international and from then on sailed with a Norwegian captain and crew, supplemented with Chilean cooks, messmen, oilers, and seamen.

Initially, *Polar Duke* was chartered to do what the *Hero* had done: perform austral summer research and resupply tasks. In the first season, which lasted from January to April 1985, the *Duke* made three cruises between Punta Arenas and the Antarctic Peninsula. The next year, however, Langdon Quetin of the University of California–Santa Barbara proposed a rare winter cruise. The success of this cruise, and one that followed during the austral winter of 1987, established *Polar Duke* as a year-round vessel. From the 1988–1989 austral summer season until its 1997 retirement, the ship logged in 275–300 days at sea per year in support of U.S. Antarctic Program science projects.

Polar Duke has made possible countless landmark projects in the disciplines of physiology, microbiology, and oceanography and, in support of science and scientists, has navigated some of the roughest waters in the world, including the always hazardous Drake Passage between South America and the Antarctic Peninsula. In addition to serving as a research laboratory, *Polar Duke* also transported people, equipment, food, construction supplies, and other materials from Tierra del Fuego to Palmer Station and to seasonal field camps and other outposts. During the 1989–1990 operating year, *Polar Duke* made its first ever port of call at McMurdo Station. From the time of its charter in 1985 until it headed north in retirement in 1997, the *Duke* left the Southern Hemisphere only once: in 1995, the vessel carried a shipment of hazardous waste to the U.S. mainland for final processing and disposal.

A new ice-strengthened research vessel, *Laurence M. Gould* will replace *Polar Duke*.

The parting of the ways

Antarctic Support Associates (ASA), the civilian support contractor for NSF, threw a party—a Cajun crawfish feed on the foredeck of the ship—for the captain and crew of the *Duke* when their service to the U.S. Antarctic Program came to an end in Port Fourchon. Dave McWilliams of ASA Marine Operations presented *Polar Duke* Captain Karl Sanden with a gift from NSF and ASA. As the *Duke* prepared to move on to other missions, McWilliams recalled ASA's and NSF's good-bye gesture:

> ASA presented a shipyard clinometer to the *Polar Duke* with a thanks for the 13 years of service to the program. During the presentation, I noted several red eyes, including my own, as the last farewells were said. It was a heart-felt thanks and acceptance. I believe all that have sailed with and held a respect for the crew and ship would have been quite pleased with the ceremony. I, for one, felt honored to have been able to represent the USAP and recognize all the good science that has been done through this vessel and the crew's efforts.

President sends greetings to antarctic stations

THE WHITE HOUSE
WASHINGTON
June 18, 1997

I am delighted to greet the international community of scientists and support personnel in Antarctica on Midwinter's Day 1997.

On this southernmost continent and in the oceans surrounding it, many nations are waging peace—upholding a 40-year tradition of cooperation that began when the pioneering representatives of 12 nations signed the Antarctic Treaty. The treaty's partnerships have brought us cooperation in science and an understanding of how Antarctica responds to natural and human-induced changes in regional or global processes.

Today, we are at the threshold of a new era in antarctic affairs, one that stresses environmental stewardship to preserve this important natural resource. This year, the United States joined other Antarctic Treaty consultative parties in ratifying the Protocol on Environmental Protection to the Antarctic Treaty. This agreement will provide comprehensive protection for the region while enabling the continuation of scientific research.

You have chosen to endure the hardships and isolation of the austral winter and are participating in a dynamic endeavor that has shown the world how people can overcome the limitations of national boundaries and ideologies to work for the good of humanity. On behalf of all who are benefiting from your efforts, I thank you for a job well done.

Best wishes for a successful stay and for a safe return to your families.

Bill Clinton

Diatoms in a South Pole ice core: Serious implications for the age of the Sirius Group

One of the most controversial topics of the past decade for paleoclimatologists has been the hypothesized existence of a Pliocene warm interval in Antarctica around 3.0–2.5 million years ago (Webb and Harwood 1991). Resolution of this controversy has been linked to the validity of two competing explanations for the presence of marine diatoms in glacigenic Sirius Formation (now called *Sirius Group*; McKelvey et al. 1991) deposits sampled from high-elevation locations (mostly higher than 1,500 meters) along a 1,000-kilometer portion of the Transantarctic Mountains (figure 1).

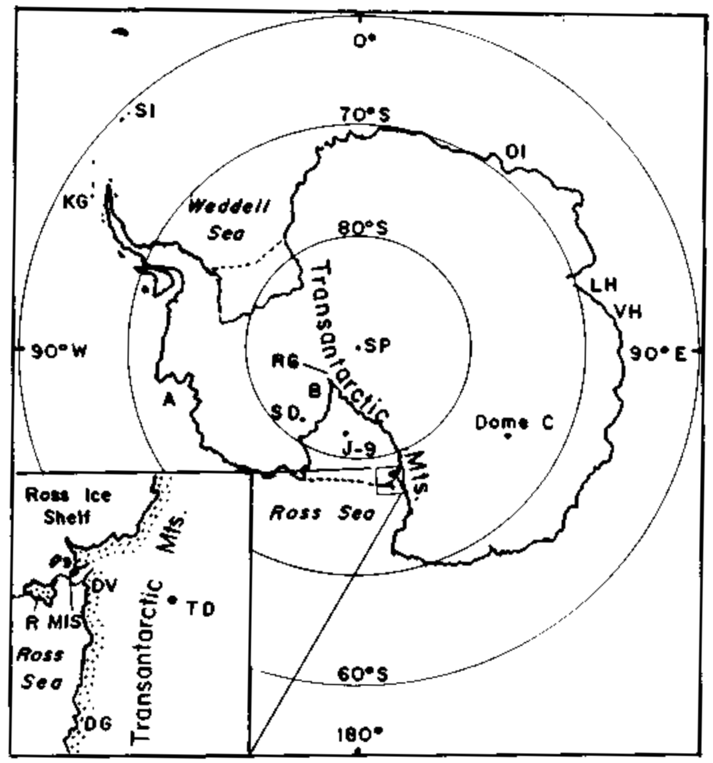

Figure 1. Map of Antarctica showing locations mentioned in text: B, ice stream B; DG, David Glacier; DV, dry valleys; J-9, Ross Ice Shelf Project site J-9; KG, King George Island; LH, Larsemann Hills; MIS, McMurdo Ice Shelf; OI, Ongul Islands; RG, Reedy Glacier; SD, Siple Dome; SI, Signy Island; TD, Taylor Dome; VH, Vestfold Hills. The Sirius Group outcrops at scattered locations in the Transantarctic Mountains from David Glacier southward to near Reedy Glacier. Wilkes and Pensacola subglacial basins are located west of the Transantarctic Mountains.

- According to the "dynamic" hypothesis (Webb et al. 1984; Harwood 1986a,b; Harwood and Webb 1995), Sirius Group sediments contain reworked Pliocene marine diatoms that are thought to have been deposited originally west of the Transantarctic Mountains in the Wilkes and Pensacola subglacial basins during a Pliocene warm interval, when the east antarctic ice sheet retreated leaving a narrow ice-free seaway. Subsequent cooling and glacial expansion resulted in grounded ice overriding the basins, incorporating marine sediments and diatoms, and subsequently, emplacing them at Transantarctic Mountains locations as the Sirius Group. This may have occurred at a time when Transantarctic Mountains elevations were 1–3 kilometers lower than they are today (Webb and Harwood 1991).

- The contrasting "stable" hypothesis argues that the east antarctic ice sheet has remained relatively unchanged for millions of years (Denton, Prentice, and Burckle 1991). Supporting data include geomorphic analyses of dry valleys landforms (Marchant et al. 1993, 1994), the preservation of delicate argon-40/argon-39–dated features in the dry valleys (McIntosh and Wilch 1995), evidence for less than 300 meters of Transantarctic Mountains uplift since the early Pliocene (Wilch et al. 1993a,b), stable isotope records from deep-sea cores that show an absolute maximum of 25 meters of sea-level increase during and since the Pliocene (Kennett and Hodell 1993, 1995), and the nature of the antarctic marine biota which suggests a stable environment over millions of years (Kennett 1995).

The diatoms in the Sirius Group represent the single key to resolving this controversy. Were these diatoms incorporated in the Sirius soon after they lived, hence providing maximum ages for Sirius emplacement, or do they represent aeolian contamination, possibly introduced long after the Sirius sediments were deposited? Here, we report on aerially transported diatoms in ice-core samples from the South Pole.

Methods and results

Material for this study comes from the 227-meter ice core drilled at the South Pole by the Polar Ice Coring Office during the 1980–1983 field seasons (Kuivinen et al. 1982). The core spans the last years between samples (stratigraphy based on information from Gow personal communication). We also sampled snow from pits at Siple and Taylor Domes.

At the National Ice Core Facility (NICL) in Denver, Colorado, the melted ice samples, which ranged in volume from 250 to 2,000 milliliters, were filtered using a Millipore system having 1.2-millimeter perforated MF "Nuclepore" filters. Dried filters were cut into six wedges, two of which were kept for archive purposes. The remaining four were placed, sample side down, on glass cover slips and cleared (made transparent) with acetic acid. Cover slips were dried and mounted on standard glass slides. Each slide was examined in its entirety at 1,000 ×, and tallies from multiple slides for each sample were combined. In addition to recording diatoms, we also noted sponge spicules, silicoflagellates, pollen grains, opal phytoliths, inorganic particulates, plant fragments, and other organic fibers.

Some workers may wonder whether our samples are contaminated and, therefore, unreliable indicators of atmospheric diatom transport. We recognize three possible stages in the processing of our samples when contaminants might be introduced:
- during drilling or core packing in the field,
- during melting and filtering at NICL, and
- in our laboratory when filters were prepared for examination.

At the South Pole, no source for diatoms is near the drilling or core-packing site. If contamination occurred at the latter times, one would expect to see a significant extra-antarctic component in the diatom assemblage. Because our samples are all dominated by typical antarctic species, we conclude that contamination is not a problem for this study.

Diatoms are a small but pervasive constituent of snow falling at the South Pole (and at Siple and Taylor Domes), although in a patchy pattern through both space and time (figure 2). Over 40 marine and nonmarine taxa were recorded (table). Abundances are extremely variable, ranging from nil to over 260 specimens in individual samples. Of 136 samples
- 34 percent contain more than 75 percent marine specimens,

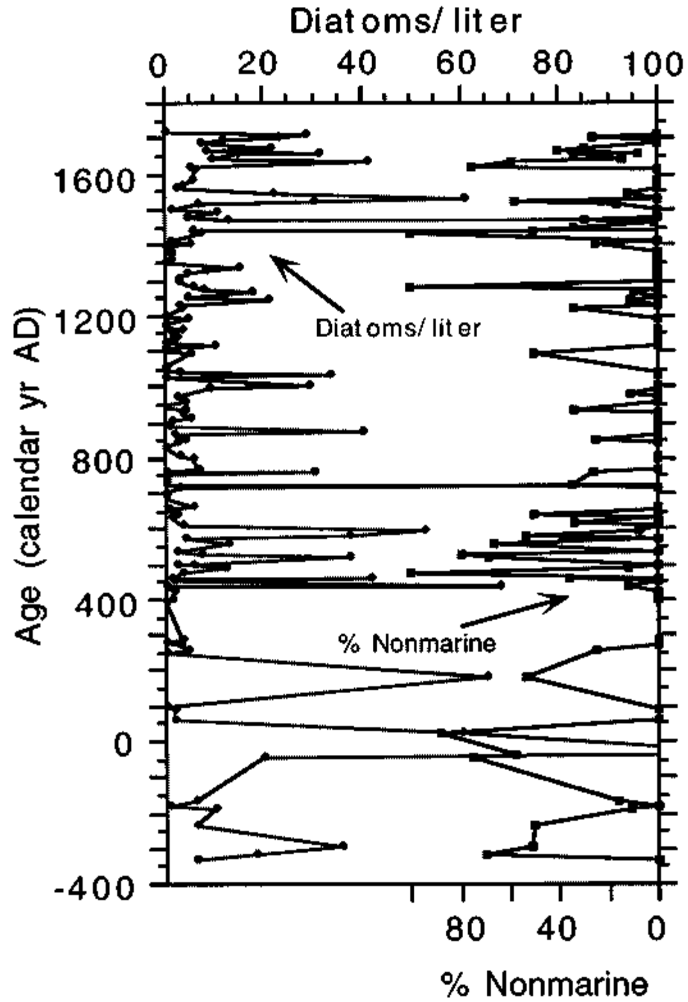

Figure 2. Diatom abundance fluctuations (specimens per liter) and percentage of nonmarine specimens in the South Pole core. Ages are calendar years based on correlation with the adjacent 1981 core at South Pole (Gow personal communication).

- 4 percent are more than 75 percent nonmarine,
- 35 percent have intermediate mixtures of marine and nonmarine taxa, and
- the remainder are barren or are dominated by species of uncertain provenance.

Most recorded species have been reported by us or other workers from a variety of antarctic sites (table). Not all taxa we report have yet been associated with antarctic source areas and may represent transport from remote locations such as the other southern continents. Census data for individual samples will be available in a separate publication (D. Kellogg in preparation).

Diatom taxa, abundance, assemblage and ecologic data

Taxon	Sample[a]	A[b]	Habitat[c]	Reported locations[d]	Notes
Achnanthes lanceolata	SP981 (2)	1	FR	EO, KG, SI	
Achnanthes sp.	SP 981 (2)	1	FR		
Actinochlus ehrenbergi	SP 440, 1460 (1)	1	MAR	A	
Actinoptychus senarius	SP 1460 (1)	1	MAR	R1, RP	
Chaetoceros diadema	TD pit D, 0 cm (1)	3	MAR		Polar waters
Chaetoceros sp.	TD pit K, 93 cm (1)	3	MAR	A, W	

Coscinodiscus marginatus	SP 1532 (10)	1	MAR	R1, RP	
Coscinodiscus radiatus	SP 1532 (6)	1	MAR	K (in red snow)	
Cyclotella comta	SP 1704 (3)	1,3	BR	A1, M, TV	
Cyclotella comta v. oligactis	SP 981 (24)	1	C	A`, TV	
Cyclotella glomerata	SP 223 m(3)	1	FR	A, M	
Cyclotella pseudostelligera ?	SP 224.5 m(3)	1	BR		Often counted as *C. stelligera*
Cyclotella stelligera	SP 981 (184)	1,3	C	A1, LM, M	
Cyclotella striata ?	SP 223 m(11)	1	BR		
Cyclotella sp.	SP 726 (21)	1,3	C	A, M, R1	Probably *C. stelligera*
Cymbella lunata	SP 1265 (1)	1	FR	SO	As *Encyconema gracilis*
Denticulopsis hustedtii	SP 1449 (1)	1	MAR	A, R1, RP, W	Miocene
Diploneus smithii	SP 440 (1)	1	BR	LH	
Diploneus sp.	SP 182 (2)	1		A1	
Fragilaria pinnata	SP 981 (1)	1	FR	KG, LG, SI	
Fragilaria virescens	SP 981 (6)	1	FR	DV	
Grammatophora sp.	SP-37 (1)	1	MAR	A, RP	
Melosira distans	SP 223 m (17)	1,3	FR	A1, DV, M	
Melosira granulata	SP-37 (28)	1	FR	LG	=*Aulasoseira granulata*
Melosira sp.	SP 981, 458 (2)	1	FR	A, M, R1	Probably *M. granulata*
Navicula festiva	SP 223 m (2)	1	FR	KG	NZ (Harper, personal communication)
Navicula muticopsis	SD camp (2)	2	FR	DV, LM, M, RO, TV	
N. muticopsis v. evoluta	TD Pit 50S, 84 cm (1)	3	FR	M, TV	
Navicula muticopsis n.v.	SD S50 W50 (15)	2	FR		Possible new variety?
Navicula sp.	SP 1637 (2)	1,2	FR?	A1, M, TV	
Nitschia aricularis ?	SD S50 W50 (3)	2	FR	EO	
Nitschia amphibia	TD pit E, 120 cm (1)	3	FR		Arctic
Nitschia closterium	TD pit I, 0 cm (1)	3	BR	M	
Nitschia curta	SD S50 W50 (1)	2	MAR	A, M, R, R1, R2, RP, TV	
Nitschia cylindra	TD pit 50S, 0 cm (11)	3	MAR	A, R1, R2	
Nitschia gracilis	SD S50 W50 (1)	2	FR	SI	
Nitschia microcephala ?	SD S50 W50 (3)	2	FR		Europe
Nitschia obliquecostata	TD pit 50S, 84 cm (1)	3	MAR	A, M, R1	
Nitschia sublineata	TD pit D 0 cm (1)	3	MAR	A, M, R1	
Nitschia sp.	SP 1460, 213 m (4)	1,2	MAR/FR	A, M, R1, RP, TV	
Paralia sulcata	SP (5 samples) (1)	1	MAR	M, RP	=*Melosira sulcata*
Pinnularia nodosa	SP 1677 (1)	1	FR		NZ (Cassie 1984)
Pinnularia maior	SP 981 (2)	1	FR		Tierra del Fuego (Frenguelli 1923) (as *Navicula maior*); NZ (Cassie 1984)
Pinnularia sp.	SP 1637 (8)	1	FR?	M	
Pseudoneunotia doliolus	SP 1449, 1460 (1)	1	MAR		Subtropics, Pleistocene
Rhabdonema sp.	SP 1440 (1)	1	MAR	M, RP	
Stephanodiscus astraea	SP (6 samples) (1)	1	FR/BR		W. Europe
Stephanopyxis turris	TD pit 50S, 0 cm (1)	3	MAR	M, R1, RP	
Synedra fasciculata	SP 981 (5)	1	FR/BR		
Tabellaria flocculosa	SP 981 (2)	1	FR	A1, TV	
T. fenestrata/quadriseptata	SP 223 m (2)	1,2	FR	A1, DV	
Thalassionema nitzschiodes	SP 458, 1532 (4)	1	MAR	A, M, R1, RP, TV, W	See *T. longissima*
Thalassiosira eccentrica	TD pits B&D (1)	3	MAR	A, R1	
Thalassiosira occulus-iridis	TD pits D&G (1)	3	MAR	A	
Thalassiosira sp.	SP 1662 (14)	1,2	MAR	A, M, R1, RP	
Thalassiothrix longissima	SD N50 W50 (119)	2,3	MAR	A, M, R1, RP, W	Includes *T. nitzschiodes* fragments
Trachyneis aspera	TD pit E, 120 cm (1)	3	MAR	A	
Trachyneis sp.	TD pit D, 80 cm (1)	3	MAR		
Centric diatom fragments	SP 1460 (53)	1,2,3		A, M, R1, RP, TV	Probably mostly marine taxa
Pennate diatom fragments	SP 981 (7)	1			
Unidentified	SP 1704 (3)	1,3			

[a]SP=South Pole; numbers are calendar age in years A.D. or depth in meters if older than 37 B.C.; TD=Taylor Dome, pit number and depth; SD=Siple Dome pit number; numbers in parantheses are maximum value recorded for the taxon in the sample listed.
[b]Assemblage: 1=South Pole; 2=Siple dome; 3=Taylor dome.
[c]MAR=Marine; FR=nonmarine; BR=brackish; C=possibly nonmarine but common in antarctic marine samples.
[d]A=Amundsen Sea marine sediments (Kellogg and Kellogg 1987a), A1=sediments and/or water on Amundsen Sea islands (Kellogg and Kellogg 1987a), DV=lakes and ponds in dry valleys (Seaburg et al. 1979), EO=East Ongul Islands (Karaswa and Fukushima 1977), K=Kerguelen Island, red snow (Fritsch 1912b), KG=King George Island (Schmidt et al. 1990), M=McMurdo Ice Shelf (Kellogg and Kellogg 1987b), LG=Lake Glubokoye (Lavrenko 1966), LH=Larsemann Hills (L. Heidi) (Gillieson 1991), LM=Lake Miers, Dry Valleys (Baker 1967), R=Ponds and sediments on Ross Island (Fritsch 1912a, and/or West and West 1911), R1=Ross Sea sediments (Truesdale and Kellogg 1979), R2=Ross Sea sediments (Barron and Burckle 1987), RP=Ross Ice Shelf Project site J-9 (Kellogg and Kellogg 1986), SI=Signy Island (Oppenheim 1990), SO=South Orkney Islands (Frenguelli 1923), TV=Taylor Valley deltas (Kellogg et al. 1980), W=west antarctic ice sheet beneath ice stream B (Scherer 1991).

Sources and atmospheric transport of diatoms

Diatoms are extremely light and easily transported by winds (e.g., the well-known diatom deposits in the equatorial Atlantic derived from Saharan Africa; Folger 1970), and winds in Antarctica are known to reach very high velocity. The antarctic surface windfield is dominated by katabatic flow, outward and down from high ice domes toward the sea (Parish and Bromwich 1987). Storms tend to track around the continent. Occasional large storms break through the circumflow and penetrate to the South Pole (Bromwich and Robasky 1993). Our diatoms were probably carried by these episodic events, which occur today at most a few times annually. An alternative transport mechanism, stratospheric return (poleward) flow, is unlikely because most of our diatoms are antarctic endemics whereas most stratospheric particles are entrained in tropical areas. Terrestrial sediments containing marine and nonmarine diatoms probably serve as the most important diatom sources. We envision diatom entrainment as episodic, perhaps occurring only a few times in a decade, and responsible for the low background level of less than 20 diatoms per liter of melted ice typical for approximately 70 percent of our samples.

Samples with higher diatom concentrations may represent short periods during which higher than normal surface winds occurred in a particular source area, or in more than one area of the coastal zone.

Specific provenances for our diatoms cannot be identified because most individual species have been reported from a number of locations (table). Marine diatom-bearing sediments are widespread in the dry valleys area of the Transantarctic Mountains, especially where Late Wisconsin Ross Sea Drift (Stuiver et al. 1981; Denton et al. 1989) is exposed. The marine species reported here are present in virtually every sample of this drift that we have examined. Similar diatom-bearing sediments are probably widespread elsewhere around the continent. That most marine specimens have been reworked from subaerially exposed sediments is further suggested by the high degree of dissolution and breakage exhibited by the marine specimens. Nonmarine diatoms are also widespread in the dry valleys, in subaerially exposed deposits, and in virtually every lake, pond, or seasonal melt pool. Many of these water bodies are ephemeral or display fluctuating water levels. Complete or partial desiccation exposes fossil material for transport by winds as described above.

Diatom deposition: Implications for the Sirius Group

Diatoms settling on the polar plateau are buried and trapped in the snow. As the snow compresses to ice and flows gradually down and outward toward the ice sheet margin, the diatoms are carried along until they reach either the glacial bed or come to the surface in an area with surface ablation (where flowlines outcrop). In the former case, diatoms from many years of deposition may become concentrated at the ice bed in morainal material. Thus, atmospherically transported diatoms have the potential to result in a reworked assemblages containing diatoms of different ages.

Not all diatoms carried through the atmosphere end up in the ice. If they land on an ice- or snow-free area, they may be retransported unless they fall in cracks or crevices protected from the wind. Evidence for this diatom-trapping mechanism was presented by Burckle (1995, in preparation) who found Pliocene/Pleistocene diatoms in cracks and crevices of antarctic sedimentary rocks. Most atmospherically transported diatoms trapped in cracks and crevices of glacigenic sedimentary deposits should remain near the surface (Stroeven and Prentice 1995), but penetration is also possible, even in compact sediments such as the Sirius Group. A thin layer of snow falling on such a sediment often melts because of heat retention by the relatively dark surface, carrying small amounts of meltwater deep into the sediment by capillary action, entraining the tiny (mostly less than 100 micrometers), delicate diatoms. Penetration should be enhanced by the presence of frost cracks in the compact Sirius sediments. We have no data suggesting how deep such penetration may go but a meter or more seems possible. We conclude that atmospheric transport routinely distributes marine and nonmarine diatoms across the antarctic ice sheet. Our data demonstrate that Sirius Group contamination by younger diatoms is unavoidable because of the pervasive and widespread effects of this atmospheric transport.

Together with our work, studies by Burckle (1995, in preparation) and Burckle and Potter (1996) of diatoms in sedimentary and igneous antarctic rocks cast serious doubts on the validity of presumed *in situ* Pliocene marine diatoms in the Sirius Group because the Pliocene diatoms are not demonstrably associated with the glacial sediments in which they occur. Hence, the entire construct of a warm Pliocene event in Antarctica is in doubt. A more complete presentation of ideas and data presented in this paper may be found in Kellogg and Kellogg (1996).

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References

Baker, A.N. 1967. Algae from Lake Miers, a solar-heated antarctic lake. *New Zealand Journal of Botany*, 5(4), 453–468.

Barron, J.A., and L.H. Burckle. 1987. Diatoms from the 1984 USGS antarctic cruise in the Ross Sea. In A.K. Cooper and F.J. Davey (Eds.), *The antarctic continental margin: Geology and geophysics of the western Ross Sea* (CPCEMR Earth Science Series, Volume 5B). Houston: Circum-Pacific Council for Energy and Mineral Resources.

Benninghoff, W.S., and A.S. Benninghoff. 1978. Airborne particles and electric fields near the ground in Antarctica. *Antarctic Journal of the U.S.*, 13(4), 163–164.

Bourelly, P., and E. Manguin. 1954. Contribution of the freshwater algae from Kerguelen. *Memoires de l'Institut Scientifique de Madagascar*, 5, 7–58. [In French]

Brady, H.T., and H. Martin. 1979. Ross Sea region in the middle Miocene: A glimpse into the past. *Science*, 203, 437–438.

Bromwich, D.H., and F.M. Robasky. 1983. Recent precipitation trends over the polar ice sheets. *Meteorology and Atmospheric Physics*, 51, 259–274.

Burckle, L.H. 1995. Upper Neogene diatoms in Beacon Supergroup (Devonian to Jurassic) sedimentary rocks: The collapse of the collapse hypothesis. Abstracts, Pliocene Antarctic Glaciation Workshop, 19–21 April 1995, Woods Hole, Massachusetts, Woods Hole Oceanographic Institution.

Burckle, L.H. In preparation. Pliocene-Pleistocene diatoms in Paleozoic and Mesozoic igneous rocks from Antarctica cast considerable doubt upon the ice sheet collapse hypothesis. *Nature*.

Burckle, L.H., R.I. Gayley, M. Ram, and J.-R. Petit. 1988. Diatoms in antarctic ice cores: Some implications for the glacial history of Antarctica. *Geology*, 16(4), 326–329.

Burckle, L.H., and N. Potter, Jr. 1996. Pliocene-Pleistocene diatoms in Paleozoic and Mesozoic sedimentary and igneous rocks from Antarctica: A Sirius problem resolved. *Geology*, 24(3) 235–238.

Cassie, V. 1984. Checklist of the freshwater diatoms of New Zealand. *Bibliotheca Diatomologica*, 4, 1–129.

De Angelis, M., N.I. Barkov, and V.N. Petrov. 1987. Aerosol concentrations over the last climate cycle (160 kyr) from an antarctic core. *Nature*, 325, 318–321.
Denton, G.H., J.G. Bockheim, S.C. Wilson, and M. Stuiver. 1989. Late Wisconsin and early Holocene glacial history, inner Ross embayment, Antarctica. *Quaternary Research*, 31(2), 151–182.
Denton, G.H., M.L. Prentice, and L.H. Burckle. 1991. Cainozoic history of the antarctic ice sheet. In R.J. Tingey (Ed.), *The geology of Antarctica*. Oxford: Clarendon University Press.
Denton, G.H., M.L. Prentice, D.E. Kellogg, and T.B. Kellogg. 1984. Late Tertiary history of the antarctic ice sheet: Evidence from the Dry Valleys. *Geology*, 12(5), 263–267.
Drebes, G. 1974. *Marine phytoplankton*. Stuttgart: Georg Thieme Verlag.
Fitzgerald, P.G. 1992. Transantarctic Mountains of southern Victoria Land: The application of apatite fission track analysis to a rift shoulder uplift. *Tectonics*, 11(3), 634–662.
Folger, D.W. 1970. Wind transport of land-derived mineral, biogenic, and industrial matter over the North Atlantic. *Deep-Sea Research*, 17, 337–352.
Frenguelli, J. 1923. Diatoms of Tierra del Fuego, part 1. *Annals of the Scientific Society of Argentina*, 96, 14–263. [In Spanish]
Frenguelli, J., and H.A. Orlando. 1958. *Diatoms and silicoflagellates of the antarctic sector of South America*. Buenos Aires: Instituto Antartico Argentino.
Fritsch, F.E. 1912a. Freshwater algae in National Antarctic Expedition 1901–1904. *Natural History* (Zoology and Botany, London), 6, 1–60.
Fritsch, F.E. 1912b. Freshwater algae of the South Orkneys, *Report on the scientific results of the voyage of S.Y. "Scotia"* (Vol. 3). Edinburgh: Publisher not given.
Germain, H. 1981. *Diatom flora*. Paris: Editions Boubee. [In French]
Gillieson, D. 1991. Diatom stratigraphy in antarctic freshwater lakes. In D. Gillieson and S. Fitzsimmons (Eds.), *Quaternary Research in Australian Antarctic* (special publication 3). Canberra: Australian Defense Force Academy, Department of Geography and Oceanography, University College.
Gow, A.J. 1995. Personal communication.
Harper, M. 1995. Personal communication.
Harwood, D.M. 1986a. Diatom biostratigraphy and paleoecology and a Cenozoic history of antarctic ice sheets. (Ph.D Thesis, Ohio State University, Columbus.)
Harwood, D.M. 1986b. Recycled siliceous microfossils from the Sirius Formation. *Antarctic Journal of the U.S.*, 21(5), 101–103.
Harwood, D.M., R.P. Scherer, and P.-N. Webb. 1989. Multiple Miocene marine productivity events in West Antarctica as recorded in upper Miocene sediments beneath the Ross Ice Shelf (site J-9). *Marine Micropaleontology*, 15, 91–115.
Harwood, D.M., and P.-N. Webb. 1995. The case for dynamic Cenozoic ice sheets in Antarctica. Abstracts, Pliocene Antarctic Glaciation Workshop, 19–21 April 1995, Woods Hole, Massachusetts, Woods Hole Oceanographic Institution.
Hogan, A., S. Barnard, J. Samson, and W. Winters. 1982. The transport of heat, water vapor and particulate material to the south polar plateau. *Journal of Geophysical Research*, 87, 4287–4292.
Hustedt, G. 1959. The diatoms of Germany, Austria, and Switzerland. Leipzig: Akademische Verlagsgesellschaft Geest and Portig K.-G. (New York: Johnson Reprint Corporation). [In German]
Karaswa, S., and H. Fukushima. 1977. Diatom flora and environmental factors in some freshwater ponds of East Ongul Island. *Antarctic Record* (Japan), 59, 46–54.
Kellogg, D.E. In preparation. Diatom evidence for high-frequency changes in high-elevation atmospheric circulation patterns above Antarctica.
Kellogg, D.E., and T.B. Kellogg. 1984. Nonmarine diatoms in the Sirius Formation. *Antarctic Journal of the U.S.*, 19(5), 44–45.
Kellogg, D.E., and T.B. Kellogg. 1986. Diatom biostratigraphy of sediment cores from beneath the Ross Ice Shelf. *Micropaleontology*, 32(1), 74–94.
Kellogg, D.E., and T.B. Kellogg. 1987a. Diatoms of the McMurdo Ice Shelf, Antarctica: Implications for sediment and biotic reworking. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 60, 77–96.
Kellogg, D.E., and T.B. Kellogg. 1987b. Microfossil distributions in modern Amundsen Sea sediments. *Marine Micropaleontology*, 12, 203–222.
Kellogg, D.E., and T.B. Kellogg. 1996. Diatoms in South Pole ice: Implications for eolian contamination of Sirius Group deposits. *Geology*, 24(2), 115–118.
Kellogg, D.E., M. Stuiver, T.B. Kellogg, and G.H. Denton. 1980. Nonmarine diatoms from Late Wisconsin perched deltas in Taylor Valley, Antarctica. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 30, 157–189.
Kellogg, T.B., and D.E. Kellogg. 1981. Pleistocene sediments beneath the Ross ice shelf. *Nature*, 293, 130–133.
Kennett, J.P. 1995. Modern shallow marine faunas of the Antarctic: Long-term evolutionary consequences of a relatively stable, isolated, cold-water ecosystem. Abstracts, Pliocene Antarctic

Glaciation Workshop, 19–21 April 1995, Woods Hole, Massachusetts, Woods Hole Oceanographic Institution.
Kennett, J.P., and D.A. Hodell. 1993. Evidence for relative climatic stability of Antarctica during the early Pliocene: A marine perspective. *Geografiska Annaler*, 75A, 205–220.
Kennett, J.P., and D.A. Hodell. 1995. Stability or instability of antarctic ice sheets during warm climates of the Pliocene? *GSA Today*, 5, 1, 10–13, 22.
Kuivinen, K.C., B.R. Koci, G.W. Holdsworth, and A.J. Gow. 1982. South Pole ice core drilling, 1981–1982. *Antarctic Journal of the U.S.*, 17(5), 89–91.
Lavrenko, G.Y. 1966. Algae of a lake near Novolazareveskaya Station. Soviet Antarctic Expedition Information Bulletin 55/56, 6, 53–66.
Marchant, D.R., G.H. Denton, J.G. Bockheim, S.C. Wilson, and A.R. Kerr. 1994. Quaternary changes in level of the upper Taylor Glacier, Antarctica: Implications for paleoclimate and east antarctic ice sheet dynamics. *Quaternary Research*, 23(1), 29–43.
Marchant, D.R., G.H. Denton, D.E. Sugden, and C.C. Swisher, III. 1993. Miocene glacial stratigraphy and landscape evolution of the western Asgard Range, Antarctica. *Geografiska Annaler*, 75A, 303–330.
McIntosh, W.C., and T. Wilch. 1995. Applications of $^{40}Ar/^{39}Ar$ dating of volcanic ash to antarctic Neogene climate and glacial history: A review of some published and ongoing studies. Abstracts, Pliocene Antarctic Glaciation Workshop, 19–21 April 1995, Woods Hole, Massachusetts, Woods Hole Oceanographic Institution.
McKelvey, B.C., P.-N. Webb, D.M. Harwood, and M.C.G. Mabin. 1991. The Dominion Range Sirius Group: A record of the late Pliocene–early Pleistocene Beardmore Glacier. In M.R.A. Thompson, J.A. Crame, and J.W. Thompson (Eds.), *Geological evolution of Antarctica*. Cambridge: Cambridge University Press.
Oppenheim, D.R. 1990. A preliminary study of benthic diatoms in contrasting lake environments. In K.R. Kerry and G. Hempel (Eds.), *Antarctic ecosystems: Ecological change and conservation* (Proceedings of the 5th SCAR Symposium on Antarctic Biology). Berlin: Springer-Verlag.
Parish, T.R., and D.H. Bromwich. 1987. The surface windfield over the antarctic ice sheets. *Nature*, 328, 51–54.
Patrick, R., and C. Reimer. 1966. *Diatoms of the United States*. Philadelphia: Academy of Natural Sciences.
Scherer, R.P. 1991. Quaternary and Tertiary microfossils from beneath ice stream B: Evidence for a dynamic west antarctic ice sheet history. *Palaeogeography, Palaeoclimatology, Palaeoecology* (Global and Planetary Change Section), 90(4), 395–412.
Schmidt, R., R. Maeusbacher, and J. Mueller. 1990. Holocene diatom flora and stratigraphy from sediment cores of two antarctic lakes (King George Island). *Journal of Paleolimnology*, 3(1), 55–74.
Seaburg, K.G., B.C. Parker, G.W. Prescott, and L.A. Whitford. 1979. The algae of southern Victoria Land, Antarctica. Vaduz: J. Cramer.
Shaw, G.E. 1978. Particles in the air at the South Pole. *Antarctic Journal of the U.S.*, 13(5), 194–196.
Stroeven, A.P., and M.L. Prentice. 1995. Marine diatoms in antarctic Tertiary tills: A new dataset from Mount Fleming, south Victoria Land, indicates possible transport mechanisms. Abstracts, Pliocene Antarctic Glaciation Workshop, 19–21 April 1995, Woods Hole, Massachusetts, Woods Hole Oceanographic Institution.
Stuiver, M., G.H. Denton, T.J. Hughes, and J.L. Fastook. 1981. History of the marine ice sheet in West Antarctica during the last glaciation: A working hypothesis. In G.H. Denton and T.J. Hughes (Eds.), *The last great ice sheets*. New York: Wiley-Interscience.
Truesdale, R.S., and T.B. Kellogg. 1979. Ross Sea diatoms: Modern assemblage distributions and their relationship to ecologic, oceanographic, and sedimentary conditions. *Marine Micropaleontology*, 4(1), 13–31.
van Heurck, H. 1896. A treatise on the diatomaceae. London: William Wesley and Son.
Webb, P.-N., and D.M. Harwood. 1991. Late Cenozoic glacial history of the Ross embayment, Antarctica. *Quaternary Science Reviews*, 10(2/3), 215–223.
Webb, P.-N., D.M. Harwood, B.C. McKelvey, J.H. Mercer, and L.D. Stott. 1984. Cenozoic marine sedimentation and ice-volume variation on the east antarctic craton. *Geology*, 12(5), 287–291.
West, W., and G.S. West. 1911. Freshwater algae. *British Antarctic Expedition (1907-1909)*, 7, 263–298.
Wilch, T.L., G.H. Denton, D.R. Lux, and W.C. McIntosh. 1993a. Limited Pliocene glacier extent and surface uplift in middle Taylor Valley, Antarctica. *Geografiska Annaler*, 75A, 331–351.
Wilch, T.I., D.R. Lux, G.H. Denton, and W.C. McIntosh. 1993b. Minimal Pliocene–Pleistocene uplift of the dry valleys sector of the Transantarctic Mountains: A key parameter in ice-sheet reconstructions. *Geology*, 21(9), 841–844.

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Recycled marine microfossils in glacial tills of the Sirius Group at Mount Fleming: Transport mechanisms and pathways

The documentation of marine microfossils in consolidated glacial sediments of the Sirius Group (McKelvey et al. 1991), radically altered the range of glacial and climatic interpretations of this deposit (e.g., Mercer 1968; Brady and McKelvey 1979; Barrett and Powell 1982; Harwood 1983; Webb and Harwood 1991; Stroeven et al. 1994; Stroeven, Prentice, and Kleman in press). A resolution of these disparate viewpoints depends critically on the inferred transport mechanism of marine microfossils from their source areas to these glacial sediments (Sugden 1992; Stroeven and Prentice 1994).

We tested marine diatom transport to the Sirius Group by considering the microfossil distribution within one key glacial deposit in the dry valleys reported to contain Neogene marine diatoms: the Sirius Group at Mount Fleming (Harwood 1986a) (figure 1). We assumed that the microfossils were recycled by the ice depositing the till and expected to find a random occurrence of diatoms in samples from the investigated deposits.

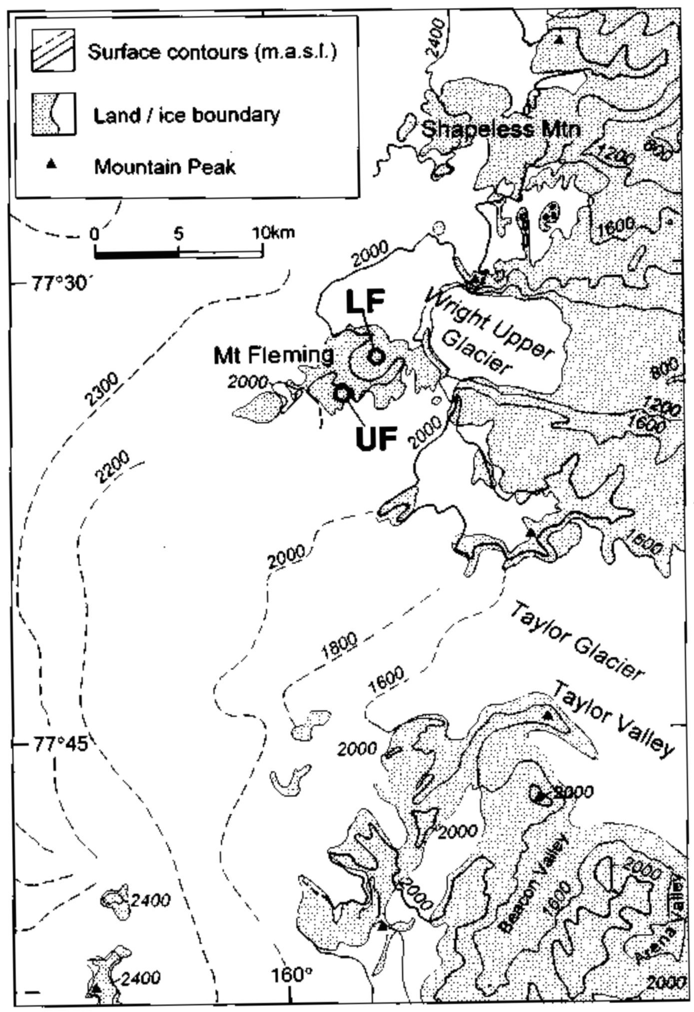

Figure 1. Index map of the dry valleys in the McMurdo Sound region with surface elevation contours. Mount Fleming is situated at the head of Wright Valley, southwest of Wright Upper Glacier. UF and LF refer to the locations of the upper and lower Fleming tills the Sirius Group at Mount Fleming (Stroeven 1994; Stroeven and Prentice in preparation).

The lithostratigraphic subdivision was threefold: consolidated, unweathered dark gray sediments overlain by moderately consolidated, weathered light gray sediments, and capped by yellow-reddish unconsolidated sediments (figure 2). We interpret the bottom two units as lodgement till emplaced by alpine ice and consider them Sirius Group equivalents (Stroeven, Prentice, and Borns 1992; Stroeven et al. 1994; Stroeven and Prentice in preparation). Because hallmark characteristics of lodgement till are absent for the surface unit, however, it could be a lag deposit from the underlying lodgement till or a glacial or nonglacial deposit unrelated to the underlying Sirius Group till. At excavations 91-001 and 91-002, dark-gray unweathered till cropped out (figure 2). At least one microfossil sample was collected from all lithostratigraphic units present in each excavation.

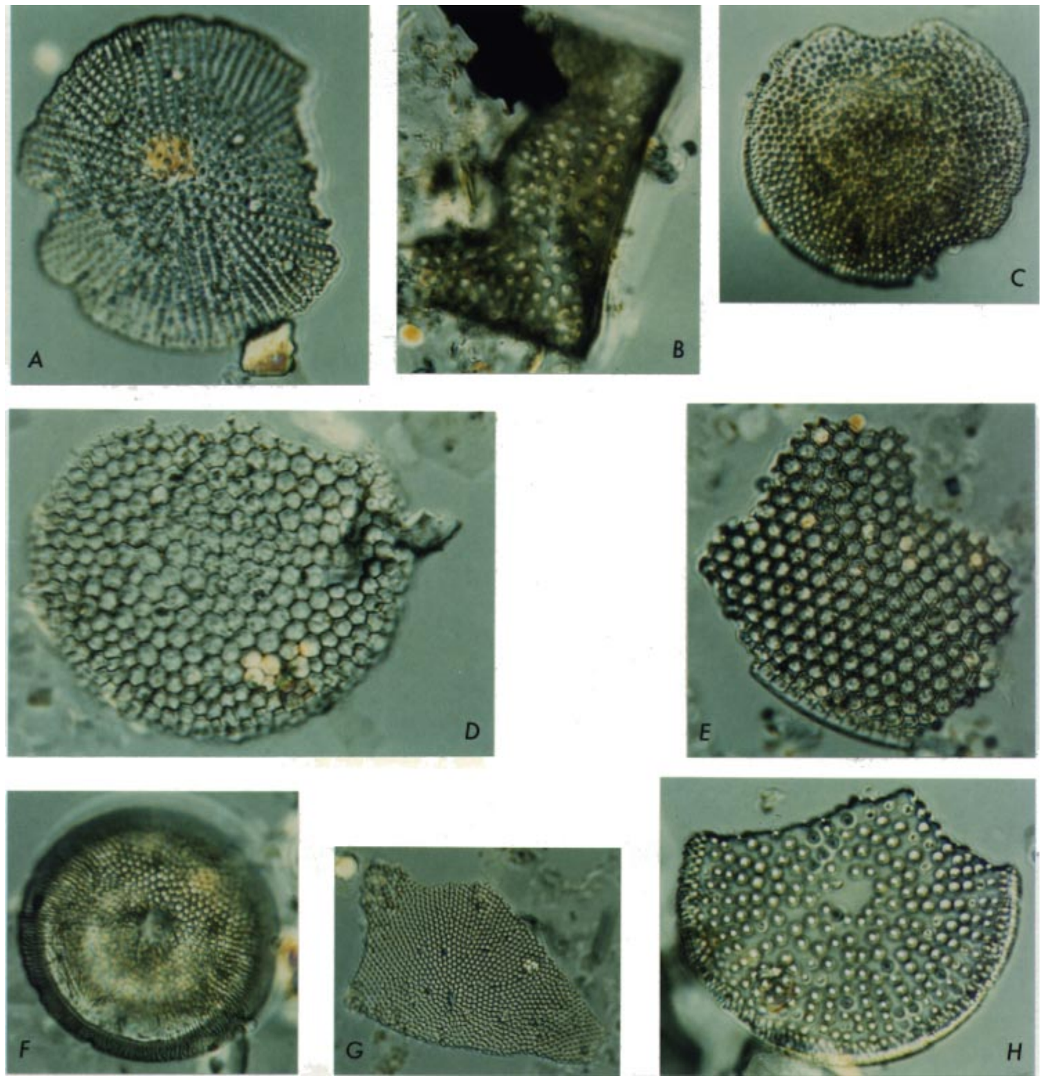

Figure 2. Pit stratigraphies for excavations 91-001, 91-002, 91-020, 91-031, and 91-038 pertain to site UF, whereas excavations 91-053, 91-054, and 91-055 pertain to site LF in figure 1. Given are the location of the excavations; the approximate depth of the excavations (depth scale is in 2.5-centimeter increments); the lithostratigraphy of the excavations; and sample location and number. In all but two excavations, three units could be distinguished: from the top-down, a loose yellow-reddish layer, capping a light-gray, massive, structureless, moderately consolidated layer, and a massive, structureless, consolidated dark-gray layer. Also given are the locations of sediment and microfossil samples (ASF 91-).

Diatom extraction followed improved standard procedures (Harwood 1986b; Harwood, Grant, and Karrer 1986; Stroeven 1994). The diatom extraction technique relies on the specific size and hydrodynamic properties of diatoms for extraction. Samples averaging 0.5 kilogram were dispersed in Calgon solution for 48 hours and introduced in a 1.2-meter settling tube. Deionized water that was filtered at 0.45 microns entered at the base of this settling tube through a plastic rod and agitated the sediment. We calculated that a water column having an upward velocity of 0.04 meters per second will float most common diatoms (i.e., diatoms that have a specific gravity less than 2.25 and a diameter less than 100 microns). The suspended material was siphoned off near the top of the tube and sieved at 25 microns. Further separation of the fraction larger than 25 microns occurred through heavy-liquid separation and centrifuging at 500 and 2,000 revolutions per minute.

We ran all samples twice through the microfossil extraction unit. The first run was on a dissolved split of the raw sample. Following these preliminary results (Stroeven and Prentice 1994), we considered the possibility that diatoms remained "stuck-together" in diatomaceous sediment microclasts. To remove all lingering organic material that could bind these microclasts, we treated the coarse (i.e., larger than 100 microns) fraction of the first run with 30 percent hydrogen peroxide and repeated the improved standard procedure. Improvements in diatom-yield were negligible (table), however, indicating that diagenetic processes played no significant role in observed diatom abundance distributions.

Occurrence of microfossils in samples from the Sirius Group at Mount Fleming. Samples in bold typeface have been taken in the loose surface unit, whereas others have been taken at depth, and refer to lodgement till samples. We ran all samples twice through the microfossil extraction unit. Improvements in diatom-yield during the second run were negligible (bottom line), indicating that diagenetic processes played no significant role in observed diatom abundance distributions. Refer to figures 1 and 2 for excavation locations (ASE) and sample locations (ASF) within each pit. Given are B=barren, B-R=barren-rare (1 diatom fragment/slide), R=rare (2-9 diatom fragments/slide), A=abundant (10 diatom fragments/slide), P=present, and HW=Harwood (1986a) samples from Mount Fleming.

ASE 91-#	**001**	**002**	<------020------>			<------031------>			<------038------>			<-----------053----------->				<-----------054----------->				<-----------055----------->				HW
ASF 91-#	**001**	**002**	**008**	009	010	**011**	012	013	**014**	015	016	**033**	034	039	040	**041**	042	043	044	**035**	036	037	038	
Depth in cm	**30-40**	**20-25**	**0-10**	15-25	50-75	**0-5**	10-20	25-35	**0-5**	5-10	30-40	**0-10**	15-35	40-45	50-80	**0-10**	15-45	55-65	70-95	**0-5**	10-20	25-45	60-75	
Region	<---------------- *upper Fleming till* ------------------>											<-------------------- *lower Fleming till* -------------------->												
Actinocyclus actinochilus						**R**			**R**			**R**												
Actinocyclus ingens																**R**								**P**
Actinoptychus senarius						**R**																		
Arachnoidiscus frg.												**R**												
Chaetoceros sp.	**R**															**R**					R			
Chaetoceros bristles																								**P**
Coscinodiscus sp. frg.			**R**			**R**										**R**								**P**
Coscinodiscus marginatus																**R**								
Coscinodiscus oculusiridis																**R**								
Denticulopsis hustedtii																								**P**
Eucampia sp. frg.																**R**								
Eucampia antarctica			**R**			**R**																		
Isthmia sp. frg.			**R**																					
Nitzschia sp.																								**P**
Odontella weisflogii	**R**					**R**																		
Rhizosolenia hebetata group																								**P**
Stephanopyxis sp.												**R**												
Stellarima microtrias			**R**			**R**										**R**								
Thalassionema sp.																					R		R	
Thalassiosira sp.			**R**			**R**										**R**							R	
Thalassiosira inura																**R**								
Thalassiosira kolbeii																**R**								
Thalassiosira lentiginosa												**R**				**R**				**R**				
Thalassiosira oliverana			**R**													**R**								
Thalassiosira torokina						**R**										**R**								
Thalassiosira vulnifica																**R**								
Thalassiothrix/Thalassionema frg.	**R**							R													R			**P**
Centric diatoms																**R**					R			
Centric diatom frg.							R								R	**R**					R	R		**P**
Diatomaceous sedim. microclasts																					A	R	R	**P**
Non-marine diatoms						**R**																		
Radiolarian frg.						**R**																		
Silicoflagellates																								**P**
Sponge spicule																**R**								
Second test	*B*	*B*	*B*	*A?*	*B*	*B*	*B*	*B*			*B*	*R?*	*B*	*B*	*B*	*B*	*B*	*B*	*B*	*B*	*B*	*B*	*B*	
Summary rating	**R**	**B**	**R**	A?	B	**A**	B-R	R	**R**	B	B	**R**	B	B	B-R	**A**	B	B	B	**B-R**	A	R	R	

In all, 23 samples from eight pits were examined for and yielded marine and nonmarine diatoms, diatomaceous sediment microclasts, radiolarian fragments, and one sponge spicule (figure 3, table). Our results indicate the existence of a marked microfossil abundance decline from the surface unit into the semiconsolidated till. This distribution is best illustrated in pits 91-031, 91-053, and 91-054 (figure 2, table). Moreover, microfossils are better preserved in the surface unit than in the till units, where they were only identified to the genus-level.

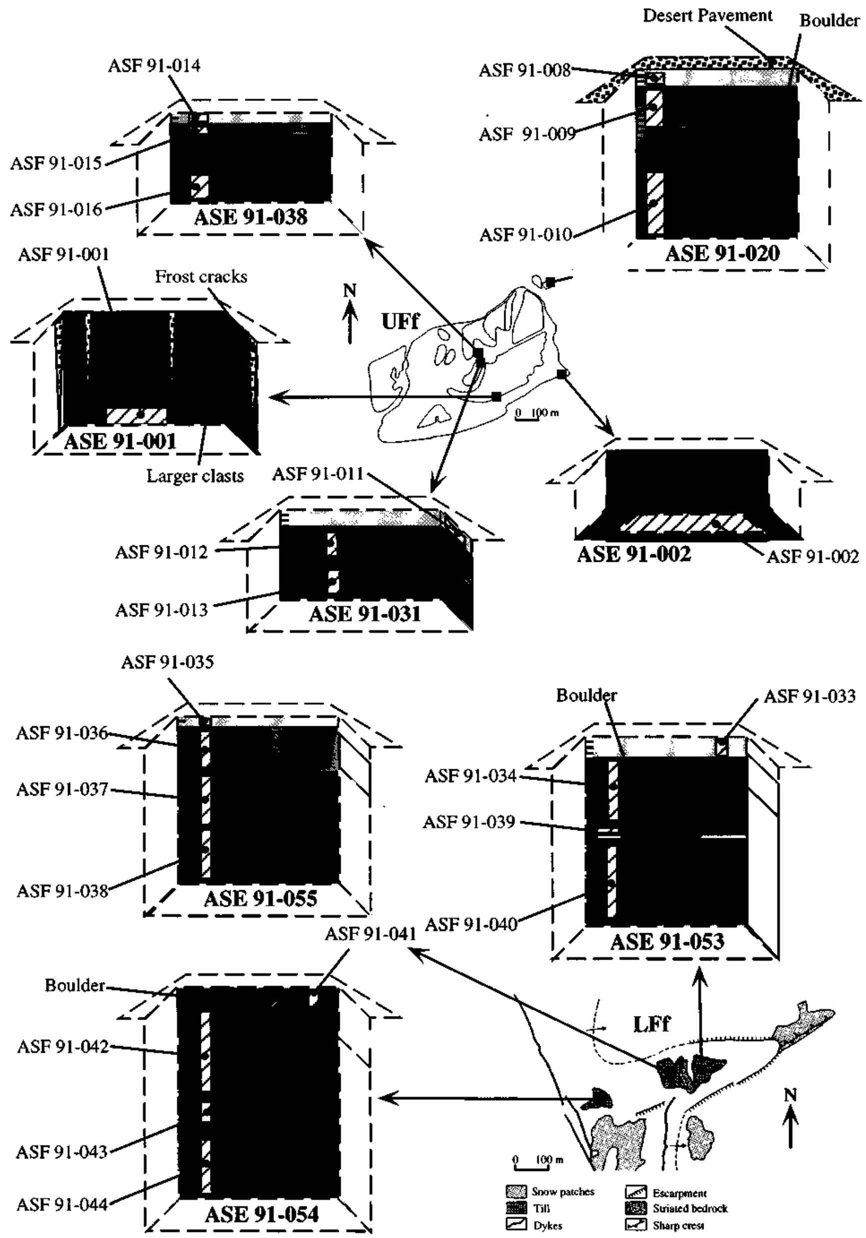

Figure 3. Diatoms recovered from surface sediments overlying the Sirius Group at Mount Fleming. Enlargement is 1,000 ×, and the diatoms were photographed from sample ASF 91-041 (figure 3), except where indicated otherwise. A. *Thalassiosira vulnifica*. B. *Eucampia antarctica*, sample ASF 91-011; C. *Thalassiosira vulnifica*. D. *Coscinodiscus marginatus*. E. *Thalassiosira kolbeii*. F. *Thalassiosira inura*. G. *Stellarima microtrias*, enlarged 750 ×. H. *Actinocyclus ingens*. Identifications as given by D. Harwood, University of Nebraska–Lincoln.

We regard it unlikely that better preserved marine diatoms at the surface were derived from the poorly preserved marine diatoms in the lodgement till units by lag processes. Instead, we suggest that the lodgement till was barren of biological material and that few diatom fragments at depth indicate a recycling-downward process in polar-desert conditions.

Critical evidence that has been used to support the subglacial reworking of diatoms into the Sirius Group till is the presence of diatomaceous sediment microclasts in the matrix of these tills (e.g., Harwood 1983, 1986a,c; Harwood, Grant, and Karrer 1986). Diatomaceous sediment microclasts were absent, however, in the matrix of the lodgement till units, except at pit 91-055 (figure 2, table). These diatomaceous sediment microclasts range in size from 25 to 40 microns, however, and do not preclude eolian transport. We suggest that the inverse stratigraphy observed in pit 91-055 is a function of either nonrepresentative surface sampling or the disintegration of fewer and larger diatomaceous sediment microclasts into a multitude of smaller ones by the extraction procedure, or both. Similarly, we suggest that the apparent abundance of microfossil fragments in sample 91-009 (pit 91-020; figure 2, table) signifies the breakdown of one or few intact diatoms into a number of unrecognizable fragments.

These results indicate that for one deposit on which the dynamicists built their viewpoint, the Sirius Group at Mount Fleming, the glacial conveyor mechanism appears erroneous. We suggest that if the microfossils in the surface unit arrived by glacial transport mechanisms, they ought to occur within a glacial deposit of younger age than the underlying lodgement tills. If the microfossils arrived by eolian processes, they should occur in surface deposits of disparate origin but of unknown age, both glacial and nonglacial, given the ability for the deposit to trap fine-grained, wind-blown material (McFadden, Wells, and Jercinovich 1987; Wells et al. 1995).

Denton, Prentice, and Burckle (1991) proposed scenarios by which airborne diatoms were incorporated into Sirius Group glacial sediments. For these diatoms to become airborne, however, at least two requirements must be met:

- Outcrops of Plio-Pleistocene marine sediments were available for subaerial wind-scouring.

- The atmospheric circulation system and the ice-sheet configuration were significantly different, so that *only* the observed Plio-Pleistocene *marine* diatom flora of the Sirius Group was elevated.

The latter is important because eolian transport at present recycles varying proportions of marine and nonmarine diatoms to east antarctic ice sheet plateau locations (Burckle et al. 1988; Kellogg and Kellogg 1996). In addition, the source area from which these marine diatoms were scoured by wind remained enigmatic, because the preponderance of planktic taxa over benthic taxa in Sirius Group sediments seemingly invalidates uplifted near-shore marine sediments (e.g., Webb and Harwood 1991) and because a stable cryosphere and marine diatom source areas appear to be conditions in contradiction. This contradiction arises because the stabilists melt-down mechanisms cannot account for the necessary ice recession (Denton et al. 1993). Finally, the absence in Sirius Group samples from Mount Fleming of marine diatom species such as *Nitzschia curta* that dominate today in circumantarctic waters (Burckle 1984) requires that the eolian microfossil conveyor operated before such species became dominant.

We advocate alternative mechanisms for deglaciation and outline one plausible scenario with marine diatom source areas and transport pathways. This scenario highlights eolian transport of Plio-Pleistocene diatoms to high-elevation deposits and is constrained by ice-volume fluctuation during the early and middle Pliocene. An, albeit short-lived, ice-volume reduction of between 10 and 40 percent of the present ice volume appears reasonable (Kennett and Hodell 1993). Denton et al. (1993) present argon-39/argon-40 constraints on the upper limit of glaciation in Taylor Valley during the last 2.97 million years. Therefore, ice is an unlikely transporting agent for diatoms in those deposits in the dry valleys situated above the last 2.97 million years maximum ice limit and having early-middle Pliocene diatom assemblages reported in them (Stroeven et al. in press).

We regard Wilkes Basin as a prime candidate for partial deglaciation because at its margin facing the open ocean, the ice sheet is partly grounded at depths in excess of 1,000 meters below present-day sea level (Drewry 1983). During proposed periods of ice recession, with associated delayed isostatic recovery, marine sedimentation occurred in these basins. Upon emergence of basin floors, strong katabatic winds from the large but shrunken east antarctic ice sheet caused deflation of the exposed marine sediments, and airborne marine diatomaceous microclasts were blown to presently high-altitude Transantarctic Mountain sites (Stroeven et al. in press). The eolian source was closed when these basins were overrun by a reexpanded east antarctic ice sheet. For marine diatom transport by glaciers, the whole length of the Wilkes and Pensacola basins has to be deglaciated to explain the spatial distribution of Pliocene marine diatom-bearing tills. For eolian diatom transport (which is directionally variable and turbulent), however, only partial deglaciation of these basins and subsequent uplift above contemporaneous sea-level, is required.

We are indebted to our co-investigators M. Helfer and C. Schlüchter and to G. Simonds, S. Dunbar, S. Iversen, and D. Rosenthal for fieldwork. D. Harwood supervised the diatom extraction procedures, identified recovered diatom species, and provided us with helpful student assistance. Helpful comments by L.H. Burckle, D. Goodwillie, and G.C. Rosqvist improved the manuscript. H. Drake drew some of the figures. We thank VXE-6 for excellent field support. This work is supported by National Science Foundation grant OPP 90-20975 to Michael L. Prentice and Harold W. Borns, Jr., by the Swedish Natural Science Research Council, and by the Swedish Society for Anthropology and Geography André grant to Arjen P. Stroeven.

References

Barrett, P.J., and R.D. Powell. 1982. Middle Cenozoic glacial beds at Table Mountain, southern Victoria Land. In C. Craddock (Ed.), *Antarctic geoscience*. Madison: University of Wisconsin Press.

Brady, H., and B. McKelvey. 1979. The interpretation of a Tertiary tillite at Mount Feather, southern Victoria Land, Antarctica. *Journal of Glaciology*, 22(86), 189–193.

Burckle, L.H. 1984. Diatom distribution and oceanographic reconstruction in the Southern Ocean—Present and last glacial maximum. *Marine Micropaleontology*, 9(3), 241–262.

Burckle, L.H., R.I. Gayley, M. Ram, and J.-R. Petit. 1988. Diatoms in antarctic ice cores: Some implications for the glacial history of Antarctica. *Geology*, 16(4), 326–329.

Denton, G.H., M.L. Prentice, and L.H. Burckle. 1991. Cainozoic history of the antarctic ice sheet. In R.J. Tingey (Ed.), *The geology of Antarctica*. Oxford: Clarendon Press.

Denton, G.H., D.E. Sugden, D.R. Marchant, B.L. Hall, and T.I. Wilch. 1993. East antarctic ice sheet sensitivity to Pliocene climatic change from a dry valleys perspective. *Geografiska Annaler*, 75A(4), 155–204.

Drewry, D.J. 1983. *Antarctica: Glaciological and geophysical folio*. Cambridge: Scott Polar Research Institute, University of Cambridge.

Harwood, D.M. 1983. Diatoms from the Sirius Formation, Transantarctic Mountains. *Antarctic Journal of the U.S.*, 18(5), 98–100.

Harwood, D.M. 1986a. Diatom biostratigraphy and paleoecology with a Cenozoic history of antarctic ice sheets. (Ph.D. dissertation, Ohio State University, Columbus, Ohio.)

Harwood, D.M. 1986b. Diatoms. In P.J. Barrett (Ed.), *Antarctic Cenozoic history from the MSSTS-1 drillhole, McMurdo Sound*. Wellington, New Zealand: Department of Scientific and Industrial Research Bulletin.

Harwood, D.M. 1986c. Recycled siliceous microfossils from the Sirius Formation. *Antarctic Journal of the U.S.*, 21(5), 101–103.

Harwood, D.M., M.W. Grant, and M.H. Karrer. 1986. Techniques to improve diatom recovery from glacial sediments. *Antarctic Journal of the U.S.*, 21(5), 107–108.

Kellogg, D.E., and T.B. Kellogg. 1996. Diatoms in South Pole ice: Implications for eolian contamination of Sirius Group deposits. *Geology*, 24(2), 115–118.

Kennett, J.P., and D.A. Hodell. 1993. Evidence for relative climatic stability of Antarctica during the early Pliocene: A marine perspective. *Geografiska Annaler*, 75A(4), 205–220.

McFadden, L.D., S.G. Wells, and M.J. Jercinovich. 1987. Influences of eolian and pedogenic processes on the origin and evolution of desert pavements. *Geology*, 15(6), 504–508.

McKelvey, B.C., P.-N. Webb, D.M. Harwood, and M.C.G. Mabin. 1991. The Dominion Range Sirius Group: A record of the late Pliocene–early Pleistocene Beardmore glacier. In M.R.A. Thomson, J.A. Crame, and J.W. Thomson (Eds.), *Geological evolution of Antarctica*. Cambridge: Cambridge University Press.

Mercer, J.H. 1968. Glacial geology of the Reedy glacier area, Antarctica. *Geological Society of America Bulletin*, 79(4), 471–486.

Stroeven, A.P. 1994. Semi-consolidated glacial deposits on Mount Fleming, South Victoria Land, Antarctica: A test of the late Neogene East Antarctic Ice Sheet collapse hypothesis. (M.S. Thesis, University of Maine, Orono, Maine.)

Stroeven, A.P., H.W. Borns, Jr., M.L. Prentice, J.L. Fastook, and R.J. Oglesby. 1994. Upper Fleming Sirius till: Evidence for local glaciation and warmer climates during the Neogene. In F.M. van der

Wateren, A.L.L.M. Verbers, and F. Tessensohn (Eds.), *Landscape evolution in the Ross Sea Area, Antarctica*. Haarlem: Rijks Geologische Dienst.

Stroeven, A.P., and M.L. Prentice. 1994. Do marine diatoms in Sirius Group tills indicate ice sheet disintegration? *Geological Society of America Abstracts With Programs,* 26(7), A-143. [Abstract]

Stroeven, A.P., and M.L. Prentice. In preparation. A case for Sirius Group alpine glaciation at Mount Fleming, south Victoria Land, Antarctica: A case against Pliocene east antarctic ice sheet reduction. *Geological Society of America Bulletin*.

Stroeven, A.P., M.L. Prentice, and H.W. Borns, Jr. 1992. Mount Fleming upper valley drift: Evidence for Neogene glacial history of Antarctica. *Antarctic Journal of the U.S.*, 27(5), 51–54.

Stroeven, A.P., M.L. Prentice, and J. Kleman. In press. On marine microfossil transport and pathways in Antarctica during the late Neogene: Evidence from the Sirius Group at Mount Fleming. *Geology*.

Sugden, D. 1992. Antarctic ice sheets at risk? *Nature*, 359, 775–776.

Webb, P.-N., and D.M. Harwood. 1991. Late Cenozoic glacial history of the Ross embayment, Antarctica. *Quaternary Science Reviews*, 10(2/3), 215–223.

Wells, S.G., L.D. McFadden, J. Poths, and C.T. Olinger. 1995. Cosmogenic ^{3}He surface-exposure dating of stone pavements: Implications for landscape evolution in deserts. *Geology*, 23(7), 613–616.

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Foundation awards of funds for antarctic projects, 1 September 1995 through 30 September 1996

Biology and medicine

Marine and terrestrial geology and geophysics

Ocean and climate studies

Astrophysics and aeronomy

Glaciology

Environmental research

Services and support

Award numbers for all awards initiated by the Office of Polar Programs (OPP) contain the prefix "OPP." ("BIR" indicates Biological Instrumentation and Resources/Directorate for Biological Sciences.) However, funding of awards is sometimes shared by two or more antarctic science or support programs within OPP or between OPP antarctic and arctic science or support programs. For these awards, a listing is included under the heading for each OPP program that funded the project. The first amount represents the funds provided by that individual program, and the second amount, in parentheses, is the total award amount. All of these contain the OPP prefix. Additionally, investigators may receive funds for antarctic research from other divisions or offices of the National Science Foundation, as well as from OPP. When awards are initiated by another NSF division, the three-letter prefix for that program is included in the award number. As with awards split between OPP programs, antarctic program funds are listed first, and the total amount is listed in parentheses.

Awards designated "(1)" were made between 1 September 1995 and 30 November 1995; awards designated "(2)" were made between 1 December 1995 and 28 February 1996; awards designated "(3)" were made between 1 March and 31 May 1996; and awards designated "(4)" were made between 1 June and 30 September 1996.

Biology and medicine

Abbott, Mark R. Oregon State University, Corvallis, Oregon. Mesoscale processes and primary productivity at the polar front. OPP 95-30507. $160,000. ($360,000) (4)

Ainley, David G. H.T. Harvey and Associates, Alviso, California. Factors regulating population size and colony distribution of Adélie penguins in the Ross Sea. OPP 95-26865. $174,824. (4)

Anderson, Robert F. Columbia University, New York, New York. Management and scientific service in support of the U.S. Joint Global Ocean Flux Study (JGOFS) southern ocean process study: Hydrography, coring, and site survey. OPP 95-30398. $294,178. (4)

Anthes, Richard. University Center for Atmospheric Research, Boulder, Colorado. University Center for Atmospheric Research Educational outreach and related activities. OPP 96-43303. $20,000. ($568,243) (4)

Arrigo, Kevin R. National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Maryland. Modeling primary production of the southern ocean for ROAVERRS (Research on Ocean-Atmosphere Variability and Ecosystem Response in the Ross Sea). OPP 95-25805. $8,582. ($43,380) (4)

Azam, Farooq. Scripps Institution of Oceanography, La Jolla, California. Bacterial production uncoupled from primary production: Implications for dissolved organic matter fluxes in the southern oceans. OPP 95-30851. $84,817. (4)

Bacon, Michael P. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Seasonal and spatial variations in the flux of particulate organic carbon derived from thorium-234 in the U.S. Joint Global Ocean Flux Study (JGOFS) southern ocean process study. OPP 95-30861. $102,026. ($121,595) (4)

Baker, Bill J. Florida Institute of Technology, Melbourne, Florida. The chemical ecology of shallow-water antarctic marine invertebrates. OPP 95-26610. $95,802. (3)

Barber, Richard T. Duke University, Durham, North Carolina. Primary production in the southern ocean. OPP 95-31981. $110,000. (4)

Barry, James P. Monterey Bay Aquarium Research Institute, Moss Landing, California. Research on Ocean-Atmosphere Variability and Ecosystem Responses in the Ross Sea (ROAVERRS). OPP 94-20680. $60,068. (4)

Bender, Michael L. University of Rhode Island, Kingston, Rhode Island. Oxygen dynamics during the Joint Global Oceans Flux Study (JGOFS) southern ocean process study. OPP 95-30746. $160,129. (4)

Bosch, Isidro M. State University of New York, Geneseo, New York. Ultraviolet photobiology of the developmental planktonic stages of antarctic benthic invertebrates. OPP 95-28089. $70,438. (3)

Bronk, Deborah A. University of Georgia, Athens, Georgia. New and regenerated production in the southern ocean: Ross Sea studies. OPP 95-30732. $29,890. (4)

Bronk, Deborah A. University of Georgia, Athens, Georgia. New and regenerated production in the southern ocean: Ross Sea studies. OPP 96-43869. $27,698. ($34,978) (4)

Caron, David A. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Seasonal contribution of nano- and microzooplankton to antarctic food web structure in the Ross Sea. OPP 96-33703. $103,458. (4)

Carpenter, Edward J. State University of New York, Stony Brook, New York. Intergovernment Personnel Act mobility assignment. OPP 96-43611. $84,529. (4)

Castellini, Michael A. University of Alaska, Fairbanks, Alaska. Physiological development and survival of juvenile Weddell seals. OPP 96-40449. $8,856. (2)

Chin, Yu-Ping. Ohio State University, Columbus, Ohio. The effect of dissolved organic matter on the photolysis and bioaccumulation of synthetic organic compounds in two lakes on Ross Island, Antarctica. OPP 96-16287. $9,000. ($50,067) (4)

Cochlan, William P. University of Southern California, Los Angeles, California. New and regenerated production in the southern ocean: Ross Sea study. OPP 95-30716. $130,659. (4)

Cowles, Timothy J. Oregon State University, Corvallis, Oregon. Southern ocean Joint Global Ocean Flux Study (JGOFS): Mesoscale physical and biological processes at the polar front. OPP 95-30758. $104,000. (4)

Day, Thomas A. Arizona State University, Tempe, Arizona. Ozone depletion, ultraviolet-B radiation and vascular plant performance in Antarctica. OPP 93-17019. $123,957 ($233,957) (1)

Delong, Edward F. University of California, Santa Barbara, California. Antarctic marine archaebacteria: Biological properties and ecological significance. OPP 94-18442. $113,620. (2)

Detrich, H. William. Northeastern University, Boston, Massachusetts. Structure, function, and expression of cold-adapted tubulins and microtubule-dependent motors from antarctic fishes. OPP 94-20712. $140,626. (3)

DeVries, Arthur L. University of Illinois at Urbana–Champaign, Champaign, Illinois. The role of antifreeze proteins in freezing avoidance of antarctic fishes. OPP 93-17629. $165,041. (3)

DiTullio, Giacomo R. University of Charleston, Charleston, South Carolina. Bloom dynamics and food web structure in the Ross Sea: Phytoplankton growth and sulfur cycling. OPP 93-17431. $85,497 ($165,773) (1)

DiTullio, Giacomo R. University of Charleston, Charleston, South Carolina. Bloom dynamics and food web structure in the Ross Sea: Phytoplankton growth and sulfur cycling. OPP 93-17431. $80,276. (2)

Ducklow, Hugh W. The College of William and Mary, Virginia Institute of Marine Sciences, Gloucester Point, Virginia. Bloom dynamics and food web structure in the Ross Sea: Primary productivity, new production and bacterial growth. OPP 93-19222. $56,246. (2)

Ducklow, Hugh W. The College of William and Mary, Virginia Institute of Marine Sciences, Gloucester Point, Virginia. Bacterial production uncoupled from primary production: Implications for dissolved organic matter fluxes in the southern ocean. OPP 95-30734. $42,058. (4)

Dunton, Kenneth H. University of Texas, Austin, Texas. Thermal adaptation in polar macroalgae. OPP 96-42085. $14,752. (3)

Fauchald, Kristian. Smithsonian Institution, Washington, DC. Biological collections from polar regions. OPP 95-09761. $150,000 ($500,000) (1)

Fauchald, Kristian. Smithsonian Institution, Washington, DC. Biological collections from polar regions. OPP 96-43726. $26,267. ($213,467) (4)

Franklin, Jerry F. University of Washington, Seattle, Washington. Stimulating and facilitating collaborative long-term ecological research: A proposal for continuing support of the LTER network office. OPP 93-00679. $89,977. ($989,759) (3)

Franks, Peter J. Scripps Institution of Oceanography, La Jolla, California. Physical-biological interactions controlling larval krill development and early survival: Implications for population recruitment and demography of *Euphausia superba* (Dana). OPP 95-25803. $152,199 ($172,199) (1)

Freckman, Diana W. Colorado State University, Fort Collins, Colorado. Antarctic dry valley nematode communities: Establishment, function, and response to disturbance. OPP 96-24743. $166,344. ($187,465) (2)

Gardner, Chester S. University of Illinois at Urbana-Champaign, Champaign, Illinois. Iron boltzman temperature lidar for studies of middle atmosphere global change. OPP 96-12251. $300,000. ($650,000) (4)

Gautier, Catherine. University of California, Santa Barbara, California. Surface ultraviolet irradiance and photosynthetically available radiation variability over Antarctica. OPP 93-17120. $138,014. (3)

Gowing, Marcia M. University of California, Santa Cruz, California. Bloom dynamics and food web structure in the Ross Sea: Role of microzooplankton in controlling production. OPP 93-16035. $217,853. (2)

Gowing, Marcia M. University of California, Santa Cruz, California. Bloom dynamics and food web structure in the Ross Sea: Role of microzooplankton in controlling production. OPP 96-43750. $10,075. (4)

Grebmeier, Jacquelin M. University of Tennessee, Knoxville, Tennessee. Research on Ocean–Atmospheric Variability and Ecosystem Response in the Ross Sea (ROAVERRS). OPP 94-20683. $52,728 (1)

Hastings, Jordan T. University of Nevada, Desert Research Institute, Reno, Nevada. Pre-Science On-Line Antarctica Planning Workshop, 28–30 April 1996 at Biosphere 2, Oracle, Arizona. BIR 95-07657. $24,927 ($74,783) (1)

Huntley, Mark E. Scripps Institution of Oceanography, La Jolla, California. Aggregation dynamics of antarctic krill, *Euphausia superba* (Dana). OPP 95-23748. $62,652 ($148,061) (1)

Huntley, Mark E. Scripps Institution of Oceanography, La Jolla, California. Aggregation dynamics of antarctic krill, *Euphausia superba* (Dana). OPP 95-23748. $69,552. (4)

Huntley, Mark E. Scripps Institution of Oceanography, La Jolla, California. U.S. Joint Global Ocean Flux Study (JGOFS) southern ocean process study: Zooplankton processes. OPP 96-34052. $200,005. (4)

Jeffrey, Wade H. University of West Florida, Pensacola, Florida. Ultraviolet-radiation-induced DNA damage in bacterioplankton in the southern ocean. OPP 94-19037. $130,665. ($135,988) (4)

Karentz, Deneb. University San Francisco, San Francisco, California. Ultraviolet photobiology of planktonic development stages of antarctic benthic invertebrates. OPP 95-28241. $86,607. (3)

Karl, David M. University of Hawaii at Manoa, Honolulu, Hawaii. Long-Term Ecological Research (LTER) on the antarctic marine ecosystem: Microbiology and carbon flux. OPP 96-40162. $64,881. (2)

Kieber, David J. State University New York, College of Environmental Science and Forestry, Syracuse, New York. Photochemical and optical properties of antarctic waters in response to changing ultraviolet-B fluxes. OPP 96-10173. $322,527. (4)

Kirchman, David L. University of Delaware, Newark, Delaware. Bacterial production uncoupled from primary production: Implications for dissolved organic matter fluxes in the southern oceans (Joint Global Ocean Flux Study). OPP 95-31977. $85,343. (4)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 95-44138. $52,801 ($10,130,714) (1)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-42445. $5,200. ($17,605,200) (4)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-43915. $40,700. ($12,890,867) (4)

Lessard, Evelyn J. University of Washington, Seattle, Washington. Bloom dynamics and food web structure in the Ross Sea: Role of microzooplankton in controlling production. OPP 93-15027. $81,081. (2)

Lonsdale, Darcy J. State University of New York, Stony Brook, New York. Seasonal contribution of nano- and microzooplankton to antarctic food web structure in the Ross Sea. OPP 96-34241. $19,023. (4)

Manahan, Donal T. University of Southern California, Los Angeles, California. Biological adaptations of antarctic marine organisms. OPP 93-17696. $167,526 (1)

Manahan, Donal T. University of Southern California, Los Angeles, California. Metabolic physiology during embryonic and larval development of antarctic echinoderms. OPP 94-20803. $130,295. (3)

Marra, John. Columbia University, New York, New York. Primary production in the southern oceans. OPP 95-30611. $130,000. (4)

McClintock, James B. University of Alabama, Birmingham, Alabama. The chemical ecology of shallow-water antarctic marine invertebrates. OPP 95-30735. $59,547. (3)

Mopper, Kenneth. Washington State University, Pullman, Washington. Photochemical and optical properties of antarctic waters in response to changing ultraviolet-B fluxes. OPP 95-27255. $386,178. (4)

Olson, Robert J. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Regulation of primary productivity in the southern oceans: Phytoplankton photosynthesis characteristics from individual cell measurements. OPP 95-30718. $120,000. (3)

Priscu, John C. Montana State University, Bozeman, Montana. Antarctic lake-ice microbial consortia: Origin, distribution, and growth physiology. OPP 94-19413. $182,055. (2)

Reed, H.L. Henry M. Jackson Foundation for the Advancement of Military Medicine, Bethesda, Maryland. The polar T_3 syndrome: Metabolic and cognitive manifestations, their hormonal regulation and impact upon performance. OPP 94-18466. $41,400. (3)

Ross, Robin M. University of California, Santa Barbara, California. Long-term ecological research on the antarctic marine ecosystem: An ice-dominated environment. OPP 96-43898. $77,182. ($96,262) (4)

Sidell, Bruce D. University of Maine, Orono, Maine. Evolution of an oxygen-binding hemoprotein in a unique environment: Myoglobin in the hemoglobinless antarctic ice-fishes. OPP 94-21657. $139,931. (2)

Smith, Kenneth L. Scripps Institution of Oceanography, La Jolla, California. Seasonal ice cover and its impact on the epipelagic community in the northwestern Weddell Sea: Long time-series monitoring. OPP 96-40796. $40,826. (2)

Smith, Kenneth L. Scripps Institution of Oceanography, La Jolla, California. Seasonal ice cover and its impact on the epipelagic community in the northwestern Weddell Sea: Long time-series monitoring. OPP 93-15029. $101,329. ($135,105) (4)

Smith, Kenneth L. Scripps Institution of Oceanography, La Jolla, California. Seasonal ice cover and its impact on the epipelagic community in the northwestern Weddell Sea: Long time-series monitoring. OPP 96-43884. $28,706. (4)

Smith, Walker O. University of Tennessee, Knoxville, Tennessee. Bloom dynamics and food web structure in the Ross Sea: Primary productivity, new production, and bacterial growth. OPP 93-17587. $122,885 ($230,402) (1)

Smith, Walker O. University of Tennessee, Knoxville, Tennessee. Bloom dynamics and food web structure in the Ross Sea: Primary productivity, new production and bacterial growth. OPP 93-17587. $107,517. (2)

Smith, Walker O. University of Tennessee, Knoxville, Tennessee. Management and scientific services in support of the U.S. Joint Global Oceans Flux Study (JGOFS) southern ocean study: Nutrients. OPP 95-30382. $256,091. (4)

Smith, Walker O. University of Tennessee, Knoxville, Tennessee. Primary production in the southern oceans. OPP 95-31990. $120,177. (4)

Stoecker, Diane K. University of Maryland, Center for Estuarian Studies, Cambridge, Maryland. Ecology and physiology of sea-ice brine microalgae. OPP 93-18772. $114,936. (3)

Trivelpiece, Wayne Z. Montana State University, Bozeman, Montana. Influence of pack ice on the distribution and demography of Pygoscelis penguins. OPP 95-43921. $70,006 (1)

Vleck, Carol M. Iowa State University, Ames, Iowa. Reproductive endocrinology of free-living Adélie penguins at Torgersen Island, Antarctica. OPP 96-42086. $4,125. (3)

Ware, Randolph H. University Center for Atmospheric Research, Boulder, Colorado. Support of UNAVCO and related activities. OPP 96-40521. $15,000. ($1,242,037) (2)

Weiler, C. Susan. Whitman College, Walla Walla, Washington. Dissertations initiative for the advancement of limnology and oceanography (DIALOG) II. OPP 96-28543. $15,000. ($45,000) (4)

Wharton, Robert A. University of Nevada, Desert Research Institute, Reno, Nevada. McMurdo Dry Valleys: A cold desert ecosystem. OPP 92-11773. $571,088. (3)

Wharton, Robert A. University of Nevada Desert Research Institute, Reno, Nevada. McMurdo Dry Valleys: A cold desert ecosystem. OPP 96-42958. $525. ($6,551) (4)

Marine and terrestrial geology and geophysics

Anandakrishnan, Sridhar. Pennsylvania State University, University Park, Pennsylvania. Antalith seismic reflection program at central west antarctica camp (CWA). OPP 96-12536. $32,189. (3)

Anandakrishnan, Sridhar. Pennsylvania State University, University Park, Pennsylvania. Workshop on aerogeophysical research in Antarctica. OPP 96-33601. $15,655. (3)

Anderson, John B. Rice University, Houston, Texas. Glacier: A collaborative antarctic curriculum. OPP 95-53878. $25,000. ($137,668) (3)

Anderson, John B. Rice University, Houston, Texas. Mechanism and timing of west antarctic ice sheet retreat at the end of the last glacial maximum. OPP 95-27876. $150,171. (3)

Andrews, John T. University of Colorado, Boulder, Colorado. Geological record of Late Wisconsin/Holocene ice-sheet advance and retreat from the Ross Sea. OPP 96-40170. $15,088 (1)

Askin, Rosemary A. Ohio State University, Columbus, Ohio. Initial palynological characterization of Cape Roberts drill cores. OPP 95-27013. $6,599. (3)

Askin, Rosemary A. Ohio State University, Columbus, Ohio. Antarctic geologic database: Rock data and sample rescue. OPP 96-26819. $49,999. (4)

Bartek, Louis R. University of Alabama, Tuscaloosa, Alabama. Glacial marine stratigraphy in the eastern Ross Sea and western Marie Byrd Land and shallow structure of the west antarctic rift. OPP 96-40605. $4,640. (2)

Bartek, Louis R. University of Alabama, Tuscaloosa, Alabama. Integrated biostratigraphy and high-resolution seismic stratigraphy of the Ross Sea: Implications for Cenozoic eustatic and climatic change. OPP 96-40607. $18,240. (2)

Bartek, Louis R. University of Alabama, Tuscaloosa, Alabama. Glacial marine stratigraphy in the eastern Ross Sea and western Marie Byrd Land and shallow structure of the west antarctic rift. OPP 93-16710. $96,489. (4)

Bell, Robin E. Columbia University, New York, New York. Lithospheric controls on the behavior of the west antarctic ice sheet: Corridor Aerogeophysics of Eastern Ross Transect Zone (CASERTZ). OPP 93-19854. $154,090. (3)

Bevis, Michael G. University of Hawaii at Manoa, Honolulu, Hawaii. Scotia Arc global positioning system project (SCARP). OPP 95-30383. $79,646. (3)

Bindschadler, Robert A. National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Maryland. Workshops for the west antarctic ice sheet project. OPP 96-34698. $7,100. ($14,201) (3)

Blankenship, Donald D. University of Texas, Austin, Texas. Lithospheric controls on the behavior of the west antarctic ice sheet: Aerogeophysics of the eastern Ross transect zone. OPP 93-19369. $2,076. ($177,076) (4)

Blankenship, Donald D. University of Texas, Austin, Texas. Support Office for Aerogeophysical Research (SOAR). OPP 96-43423. $333,903. ($1,043,703) (4)

Cande, Steven C. Scripps Institution of Oceanography, La Jolla, California. Early Tertiary tectonic evolution of the Pacific-Australia-Antarctic Plate circuit. OPP 94-16989. $65,755 ($366,041) (1)

Cande, Steven C. Scripps Institution of Oceanography, La Jolla, California. Early Tertiary tectonic evolution of the Pacific-Australia-Antarctic Plate circuit. OPP 94-16989. $19,356. ($139,347) (2)

Cande, Steven C. Scripps Institution of Oceanography, La Jolla, California. Late Cretaceous–Early Tertiary plate interactions in the southwest Pacific. OPP 93-17872. $24,684. ($74,684) (2)

Cassidy, William A. Case Western Reserve, Cleveland, Ohio. Antarctic search for meteorites. OPP 91-17558. $91,891. (3)

Cole, Julia E. University of Colorado, Boulder, Colorado. Acquisition of a stable isotope mass spectrometer for automated carbonate analysis: Analytical instrumentation for earth science/global change research. OPP 96-28080. $9,500. ($113,487) (4)

Dalziel, Ian W. University of Texas, Austin, Texas. Geologic studies in the Shackleton Range Coats Land and Queen Maud Land, East Antarctica: A North American connection. OPP 96-42724. $64,977. (4)

Davies, Thomas A. University of Texas, Austin, Texas. Atlas of glacimarine features. OPP 95-26459. $34,833. (2)

DePaolo, Donald J. University of California, Berkeley, California. Metamorphism and intrusion chronology and tectonic evolution of the central and southern Transantarctic Mountains using samarium-neodymium isotopes. OPP 93-18838. $39,489. (2)

Domack, Eugene W. Hamilton College, Clinton, New York. Geological record of Late Wisconsinan/Holocene ice-sheet advance and retreat from Ross Sea. OPP 96-41121. $1,850. (3)

Duebendorfer, Ernest M. Northern Arizona University, Flagstaff, Arizona. The Ellsworth Mountain terrane: Its origin and accretion to East Antarctica. OPP 93-12040. $20,448. (3)

Elliot, David H. Ohio State University, Columbus, Ohio. Jurassic volcanic rocks in the Transantarctic Mountains: A test of a model for continental flood basalt magmatism in Antarctica. OPP 94-20498. $128,230. (3)

Elliot, David H. Ohio State University, Columbus, Ohio. Mesozoic break-up of Gondwanaland: Geochronology of antarctic tholeiites. OPP 95-27816. $247,000. (3)

Faure, Gunter. Ohio State University, Columbus, Ohio. Age of the last transgression of the east antarctic ice sheet, Transantarctic Mountains, southern Victoria Land. OPP 93-16310. $13,453. ($26,913) (3)

Feldmann, Rodney M. Kent State University, Kent, Ohio. Paleobiogeography of austral decapod crustaceans. OPP 95-26252. $41,000. ($61,000) (2)

Finn, Carol. U.S. Geological Survey, Reston, Virginia. Lithospheric controls on the behavior of the west antarctic ice sheet: Corridor Aerogeophysics of the Eastern Ross Transect Zone (CASERTZ/WAIS). OPP 96-43267. $48,054. (4)

Fitzgerald, Paul. University of Arizona, Tucson, Arizona. Thermochronologic constraints on the formation of the Transantarctic Mountains, Antarctica. OPP 93-16720. $98,154. (4)

Frey, Frederick A. Massachusetts Institute of Technology, Cambridge, Massachusetts. Origin and evolution of the Kerguelen plume: Constraints from studies of the Kerguelen Archipelago. OPP 94-17774. $45,880. (2)

Goodge, John W. Southern Methodist University, Dallas, Texas. Antarctic Working Group for Geology and Geophysics 1996–1998. OPP 96-15562. $23,426. (4)

Grunow, Anne M. Ohio State University, Columbus, Ohio. Establishment of Gondwana early Paleozoic reference poles and tests for terrane motion. OPP 93-17673. $76,641. (3)

Hammer, William R. Augustana College, Rock Island, Illinois. Vertebrate paleontology of the Triassic to Jurassic sedimentary sequence in the Shackleton Glacier regions, Antarctica. OPP 93-15826. $61,321. (3)

Harvey, Ralph P. Case Western Reserve, Cleveland, Ohio. Support for Meteorite Working Group meeting, 27–28 September 1996, Arlington, Virginia. OPP 96-15721. $11,529. (4)

Harwood, David M. University of Nebraska, Lincoln, Nebraska. High-latitude southern ocean paleontology workshop. OPP 96-34616. $10,800. (3)

Harwood, David M. University of Nebraska, Lincoln, Nebraska. Integrated biostratigraphy and high-resolution seismic stratigraphy of the Ross Sea: Implication for Cenozoic eustatic and climatic changes. OPP 96-42036. $21,322. (3)

Harwood, David M. University of Nebraska, Lincoln, Nebraska. Paleobiology and paleoenvironments of preglacial(?) Eocene coasts in southern Victoria Land, Antarctica. OPP 93-17901 $41,088. (3)

Harwood, David M. University of Nebraska, Lincoln, Nebraska. Diatom biostratigraphy and paleoenvironmental history of Cape Roberts Project cores. OPP 94-20062. $30,923. (4)

Harwood, David M. University of Nebraska, Lincoln, Nebraska. Paleobiology and paleoenvironments of preglacial(?) Eocene coasts in southern Victoria Land, Antarctica. OPP 96-43359. $12,000. (4)

Hayes, Dennis E. Columbia University, New York, New York. Analysis of circumantarctic ocean basin paleobathymetry and structure. OPP 94-18936. $90,894. (2)

Jarrard, Richard D. University of Utah, Salt Lake City, Utah. Downhole logging for the Cape Roberts Project. OPP 94-18429. $120,784. (4)

Jarrard, Richard D. University of Utah, Salt Lake City, Utah. Stress field history, Cape Roberts Antarctica. OPP 95-27319. $14,838. (4)

Kamb, Barclay. California Institute of Technology, Pasadena, California. Global positioning system measurements of crustal motion in Antarctica. OPP 95-27606. $94,397. (4)

Kettler, Richard M. University of Nebraska, Lincoln, Nebraska. Initial characterization of organic matter in Cretaceous–Paleogene sedimentary Rocks, Cape Roberts, Antarctica. OPP 95-27070. $22,359. (3)

Klinkhammer, Gary. Oregon State University, Corvallis, Oregon. A survey of hydrothermal vents in Bransfield Strait, Antarctica. OPP 96-40130. $18,000 (1)

Klinkhammer, Gary. Oregon State University, Corvallis, Oregon. A survey of hydrothermal vents in Bransfield Strait, Antarctica. OPP 96-42795. $27,300. (4)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-40584. $3,771. ($25,503,771) (2)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-41407. $21,000. ($7,021,000) (3)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-43915. $113,613. ($12,890,867) (4)

Krissek, Lawrence A. Ohio State University, Columbus, Ohio. Initial sedimentological characterization of the Late Cretaceous–Early Cenozoic drill cores from Cape Roberts, Antarctica. OPP 95-27008. $28,363. (3)

Krissek, Lawrence A. Ohio State University, Columbus, Ohio. Initial sedimentological characterization of the Late Cretaceous–Early Cenozoic drill cores from Cape Roberts, Antarctica. OPP 96-43364. $3,800. (4)

Kurz, Mark D. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Pliocene history of the east antarctic ice sheet: A workshop. OPP 96-40004. $2,150 ($4,300) (1)

Kurz, Mark D. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Sources of Cenozoic volcanism in McMurdo Sound: An isotopic study. OPP 96-40513. $15,539. (2)

Kyle, Philip R. New Mexico Institute of Mining and Technology, Socorro, New Mexico. The Cape Roberts Project: Volcanic record, geochemistry, and argon-40/argon-39 chronology. OPP 95-27329. $60,231. (3)

Kyle, Philip R. New Mexico Institute of Mining and Technology, Socorro, New Mexico. Mount Erebus Volcano Observatory. OPP 94-19267. $76,389. (4)

Lawver, Lawrence A. University of Texas, Austin, Texas. Scotia Arc Global Positioning System Project (SCARP). OPP 95-26687. $79,993. (4)

Luyendyk, Bruce P. University of California, Santa Barbara, California. Glacial marine stratigraphy in the eastern Ross Sea and western Marie Byrd Land and shallow structure of the west antarctic rift. OPP 96-40312. $26,640. (2)

Luyendyk, Bruce P. University of California, Santa Barbara, California. Glacial marine stratigraphy in the eastern Ross Sea and western Marie Byrd Land and shallow structure of the west antarctic rift. OPP 93-16712. $49,748. (4)

Marchant, David R. Boston University, Boston, Massachusetts. Tephrochronology applied to Late Cenozoic Paleoclimate and geomorphic evolution of the central Transantarctic Mountains. OPP 96-14027. $53,018. (4)

Marsh, Bruce D. Johns Hopkins University, Baltimore, Maryland. Three-dimensional magma dynamics in large sills. OPP 94-18513. $110,003. (3)

Marsh, Bruce D. Johns Hopkins University, Baltimore, Maryland. Three-dimensional magma dynamics in large sills. OPP 96-43236. $9,372. ($15,012) (4)

Nishiizumi, Kunihiko. University of California, Berkeley, California. Terrestrial age measurement of antarctic meteorites. OPP 96-40199. $9,000. (2)

Pittenger, Richard F. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Ship operations. OPP 96-43819. $24,000. ($57,500) (4)

Pospichal, James J. Florida State University, Tallahassee, Florida. Calcareous nanofossil biostratigraphy and paleoenvironmental history of the Cape Roberts Project cores. OPP 94-22893. $37,607. (4)

Powell, Ross D. Northern Illinois University, De Kalb, Illinois. Initial sedimentological characterization of the Late Cretaceous–Early Cenozoic drill cores from Cape Roberts, Antarctica. OPP 95-27481. $31,781. (3)

Rea, David K. University of Michigan, Ann Arbor, Michigan. The record of antarctic environment preserved in deep sea sediments: Critical times of climate change. OPP 95-27067. $225,349. (2)

Rees, Margaret N. University of Nevada, Las Vegas, Nevada. The Ellsworth Mountains terrane: Its origin and accretion to East Antarctica. OPP 92-20395. $99,739. (4)

Scherer, Reed. University of Massachusetts, Amherst, Massachusetts. Diatom biostratigraphy and paleoenvironmental history of Cape Roberts cores. OPP 94-22894. $12,576. (4)

Shen, Yang. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Models of the three-dimensional stratigraphy of glaciated continental shelves. OPP 95-26930. $40,000. (4)

Shimizu, Nobumichi. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Origin and evolution of the Kerguelen plume: Constraints from studies of the Kerguelen Archipelago. OPP 94-17806. $34,120. (2)

Smalley, Robert. University of Memphis, Memphis, Tennessee. Scotia Arc global positioning system project (SCARP). OPP 95-27529. $52,592. (3)

Spilhaus, A.F. American Geophysical Union, Washington, DC. Support of travel to 30th International Geological Congress, Beijing, China, 4–14 August 1996. OPP 96-27219. $2,000. ($14,000) (4)

Stock, Joann M. California Institute of Technology, Pasadena, California. Early Tertiary tectonic evolution of the Pacific-Australia-Antarctic Plate circuit. OPP 94-16779. $42,694 ($80,611) (1)

Stock, Joann M. California Institute of Technology, Pasadena, California. Late Cretaceous–Early Tertiary plate interactions in the southwest Pacific. OPP 96-40039. $18,390. (2)

Stock, Joann M. California Institute of Technology, Pasadena, California. Late Cretaceous–Early Tertiary plate interactions in the southwest Pacific. OPP 93-17318. $75,759. (3)

Stock, Joann M. California Institute of Technology, Pasadena, California. Early Tertiary tectonic evolution of the Pacific-Australia-Antarctic Plate circuit. OPP 94-16779. $37,917. (4)

Stump, Edmund. Arizona State University, Tempe, Arizona. Dinofest International: Innovative science education outreach. OPP 96-26879. $10,000. ($40,000) (4)

Taylor, Edith L. University of Kansas, Lawrence, Kansas. The Shackleton Glacier area: Floristics, biostratigraphy, and paleoclimate. OPP 93-15353. $141,981. (2)

Verosub, Kenneth L. University of California, Davis, California. Paleomagnetic and mineral magnetic characterization of drill cores from the Cape Roberts project. OPP 95-26889. $108,662. (3)

Ware, Randolph H. University Center for Atmospheric Research, Boulder, Colorado. Support of UNAVCO and related activities. OPP 96-40521. $28,600. ($1,242,037) (2)

Watkins, David K. University of Nebraska, Lincoln, Nebraska. Calcareous nanofossil biostratigraphy and paleoenvironmental history of Cape Roberts cores. OPP 94-19770. $3,386. (4)

Webb, Peter-Noel. Ohio State University, Columbus, Ohio. Integrated biostratigraphy and high-resolution seismic stratigraphy of the Ross Sea: Implications for Cenozoic eustatic and climate change. OPP 96-41979. $19,999. (3)

Webb, Peter-Noel. Ohio State University, Columbus, Ohio. Antarctic stratigraphic drilling: Cape Roberts Project. OPP 93-17979. $48,271. (4)

Webb, Peter-Noel. Ohio State University, Columbus, Ohio. Cretaceous–Paleogene foraminifera of the Victoria Land Basin (Cape Roberts Project). OPP 94-20475. $33,935. (4)

Whillans, Ian M. Ohio State University, Columbus, Ohio. Global positioning system measurements of rock and ice motions in southern Victoria Land. OPP 95-27571. $56,021. (4)

Wiens, Douglas. Washington University, St. Louis, Missouri. A broadband seismic experiment for study of the tectonics and structure of the Antarctic Peninsula and Scotia Sea regions. OPP 95-27366. $109,057. (3)

Wilson, Gary S. Ohio State University, Columbus, Ohio. Paleomagnetic and mineral magnetic characterization of drill cores from the Cape Roberts project. OPP 95-27343. $24,957. (3)

Wilson, Gary S. Ohio State University, Columbus, Ohio. Mount Feather Sirius Group workshop and collaborative sample analysis and publication. OPP 96-34644. $10,868. ($21,735) (3)

Wilson, Terry J. Ohio State University, Columbus, Ohio. Stress field history, Cape Roberts, Antarctica. OPP 95-27394. $84,018. (4)

Wise, Sherwood W. Florida State University, Tallahassee, Florida. Curatorship of antarctic collections. OPP 96-40466. $99,280. (2)

Wise, Sherwood W. Florida State University, Tallahassee, Florida. Curatorship of antarctic collections. OPP 96-43483. $21,904. (4)

Witmer, Richard E. U.S. Geological Survey, Reston, Virginia. Antarctic surveying and mapping program. OPP 96-43361. $217,800. ($335,600) (4)

Wrenn, John H. Louisiana State University and A&M College, Baton Rouge, Louisiana. Initial palynological characterization of Cape Roberts drill cores. OPP 95-27075. $60,788. (3)

Zoback, Mark D. Stanford University, Stanford, California. Stress field history, Cape Roberts, Antarctica. OPP 95-27412. $26,648. (4)

Ocean and climate studies

Ackley, Stephen F. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. Sea-ice measurements during the Antarctic Zone Winter Flux Experiment (ANZFLUX). OPP 96-42694. $78,446. (4)

Anderson, Robert F. Columbia University, New York, New York. Proxies of past changes in southern ocean productivity: Modeling and experimental development. OPP 95-30379. $87,000. (4)

Asper, Vernon L. University of Southern Mississippi, Hattiesburg, Mississippi. Bloom dynamics and food web structure in the Ross Sea: Vertical flux of carbon and nitrogen. OPP 93-17598. $89,969. (2)

Bacon, Michael P. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Seasonal and spatial variations in the flux of particulate organic carbon derived from thorium-234 in the U.S. Joint Global Ocean Flux Study (JGOFS) southern ocean process study. OPP 95-30861. $19,569. ($121,595) (4)

Bacon, Michael P. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Thorium isotopes as indicators of export flux and particle dynamics in the southern ocean: Joint Global Ocean Flux Study (JGOFS). OPP 95-30720. $113,346. (4)

Bromwich, David H. Ohio State University, Columbus, Ohio. An evaluation of numerical weather prediction in high southern latitudes with first regional observing study of the troposphere (FROST) observations. OPP 94-22104. $43,618. ($87,236) (3)

Bromwich, David H. Ohio State University, Columbus, Ohio. Research on Ocean-Atmosphere Variability and Ecosystem Response in the Ross Sea (ROAVERRS). OPP 94-20681. $69,715. (4)

Coale, Kenneth H. San Jose State University, San Jose, California. Iron in antarctic polar front zones. OPP 95-30762. $312,081. (4)

Cochran, J. Kirk. State University of New York, Stony Brook, New York. Thorium isotopes as indicators of export flux and particle dynamics in the southern ocean: Joint Global Ocean Flux Study (JGOFS). OPP 96-12761. $100,000. (4)

Dunbar, Robert B. Rice University, Houston, Texas. Research on Ocean–Atmosphere Variability and Ecosystem Response in the Ross Sea (ROAVERRS). OPP 94-19605. $69,702. (2)

Dymond, Jack R. Oregon State University, Corvallis, Oregon. Latitudinal variations of particle fluxes in the southern oceans: A bottom-tethered sediment trap array experiment. OPP 96-14028. $248,672. (4)

Foster, Theodore D. University of Delaware, Newark, Delaware. Deep water formation off the eastern Wilkes Land coast of Antarctica. OPP 93-17379. $95,000. (2)

Goyet, Catherine. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Distribution, sources, and sinks of dissolved organic matter in the southern oceans. OPP 95-30609. $105,809. (4)

Guest, Peter S. Naval Postgraduate School, Monterey, California. Atmospheric forcing during the Antarctic Zone Winter Flux Experiment (ANZFLUX). OPP 96-41279. $42,979. (3)

Hall, Michael J. National Oceanic and Atmospheric Administration, Washington, DC. Support for Argos data collection and location system. OPP 96-42925. $20,158. ($638,651) (4)

Hansell, Dennis A. Bermuda Biological Station Research, Ferry Reach, Bermuda. Bloom dynamics and food web structure in the Ross Sea: Dynamics of dissolved organic carbon. OPP 93-17200. $113,408. (2)

Hayes, John M. Indiana University, Bloomington, Indiana. Factors controlling the abundance of carbon-13 in algal and sedimentary biomarkers from the Amundsen and Bellingshausen Seas, Antarctica. OPP 94-18833. $104,262. (2)

Hedges, John I. University of Washington, Seattle, Washington. Organic geochemical studies in the southern oceans. OPP 95-31763. $100,322. (4)

Honjo, Susumu. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Latitudinal variations of particle fluxes in the southern ocean: A bottom-tethered sediment trap array experiment. OPP 95-30300. $382,712. (4)

Jeffries, Martin O. University of Alaska, Fairbanks, Alaska. The role of snow in antarctic sea-ice development and ocean-atmosphere energy exchange. OPP 93-16767. $70,445. (4)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 95-44138. $50,546 ($10,130,714) (1)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-43915. $15,568. ($12,890,867) (4)

Lee, Cindy L. State University of New York, Stony Brook, New York. Organic geochemical studies in the southern oceans. OPP 95-30891. $95,347. (4)

Leventer, Amy. University of Minnesota at the Twin Cities, Minneapolis, Minnesota. Research on Ocean–Atmosphere Variability and Ecosystem Response in the Ross Sea (ROAVERRS). OPP 94-20682. $66,836 ($130,043) (1)

Leventer, Amy. University of Minnesota at the Twin Cities, Minneapolis, Minnesota. Research on Ocean–Atmosphere Variability and Ecosystem Response in the Ross Sea (ROAVERRS). OPP 94-20682. $63,207. (2)

Lowenthal, Douglas H. University of Nevada, Desert Research Institute, Reno, Nevada. Particulate matter less than 10 microns in size (PM10) source apportionment at McMurdo Station, Antarctica. OPP 95-44154. $2,856 ($147,856) (1)

Martinson, Douglas G. Columbia University, New York, New York. ANZFLUX (Antarctic Zone Flux Experiment) conductivity-temperature-depth/tracer program. OPP 93-17231. $300,000. (4)

McPhee, Miles G. McPhee Research, Naches, Washington. Upper ocean turbulent fluxes and mixing in the Weddell Sea. OPP 93-15920. $70,000. (3)

Millero, Frank J. University of Miami, Coral Gables, Florida. The carbon dioxide system in the southern oceans. OPP 95-30384. $128,181. (4)

Muench, Robin D. Science Applications International Corporation, San Diego, California. Acoustic Doppler Current Profile and mesoscale current observations in the eastern Weddell Sea: A component of the Antarctic Zone Flux Experiment (ANZFLUX). OPP 93-15019. $85,864. (2)

Nelson, David M. Oregon State University, Corvallis, Oregon. Bloom dynamics and food-web structure in the Ross Sea: The irradiance/mixing regime and diatom growth in spring. OPP 93-17538. $139,011. (2)

Padman, Laurence. Oregon State University, Corvallis, Oregon. Heat, salt, and momentum fluxes through the pycnocline in the eastern Weddell Sea. OPP 93-17321. $105,757. (2)

Quay, Paul D. University of Washington, Seattle, Washington. Physical and biological controls of carbon dioxide levels in the southern oceans: A multitracer approach. OPP 95-30824. $200,000. (4)

Roesler, Collin. University of Connecticut, Storrs, Connecticut. Solar radiation processes in the east antarctic sea-ice zone. OPP 95-27244. $69,347. (3)

Shen, Hayley H. Clarkson University, Potsdam, New York. Wave and pancake ice interactions. OPP 96-43861. $10,200. (4)

Stanton, Timothy P. Naval Postgraduate School, Monterey, California. Mixed-layer turbulence measurements during the Antarctic Zone Winter Flux Experiment (ANZFLUX). OPP 96-42033. $60,000. (4)

Takahashi, Taro. Columbia University, New York, New York. Measurements of carbon dioxide during the southern ocean Joint Global Ocean Flux Study (JGOFS). OPP 95-30684. $340,000. (4)

Tape, Walter. University of Alaska, Fairbanks, Alaska. Antarctic halos and ice crystals. OPP 94-19235. $1 ($155,465) (1)

Tape, Walter. University of Alaska, Fairbanks, Alaska. Antarctic halos and ice crystals. OPP 94-19235. $77,732. ($155,464) (3)

Wakeham, Stuart G. Skidaway Institute of Oceanography, Savannah, Georgia. Organic geochemical studies in the southern oceans. OPP 95-31759. $94,672. (4)

Warren, Stephen G. University of Washington, Seattle, Washington. Climate processes on the antarctic plateau. OPP 94-21096. $199,857. (2)

Warren, Stephen G. University of Washington, Seattle, Washington. Solar radiation processes in the east antarctic sea-ice zone. OPP 95-27245. $75,749. (4)

Wendler, Gerd. University of Alaska, Fairbanks, Alaska. Investigations of katabatic wind and its interaction with sea ice. OPP 94-13879. $125,718. (2)

Wettlaufer, John S. University of Washington, Seattle, Washington. Interfacial melting and frost heave in ice. OPP 95-23513. $101,092. (4)

Astrophysics and aeronomy

Arnoldy, Roger L. University of New Hampshire, Durham, New Hampshire. Continuation support of high-latitude geomagnetic pulsation measurements. OPP 92-17024. $67,450 ($329,590) (1)

Baker, Kile B. Johns Hopkins University, Baltimore, Maryland. Multiradar studies of the dynamics of the antarctic ionosphere. OPP 94-21266. $35,000. ($75,000) (4)

Bieber, John W. Bartol Research Institute, Newark, Delaware. Solar and heliospheric studies with antarctic cosmic ray observations. OPP 95-28122. $200,184. (4)

Deshler, Terry L. University of Wyoming, Laramie, Wyoming. Vertical profiles of polar stratospheric clouds. Condensation nuclei, ozone, nitric acid, and water vapor in the antarctic winter and spring stratosphere. OPP 93-16774. $394,911. (3)

Engebretson, Mark J. Augsburg College, Minneapolis, Minnesota. Induction antennas for British Antarctic Survey automatic geophysical observatories. OPP 93-16750. $83,759. (2)

Fitzsimmons, Stephen J. ABT Associates, Inc., Cambridge, Massachusetts. Evaluation of the National Science Foundation's Science and Technology Centers Program. OPP 96-41277. $5,750. ($44,502) (3)

Forbes, Jeffrey M. University of Colorado, Boulder, Colorado. Planetary waves in the antarctic mesopause region. OPP 93-20879. $27,156. (2)

Fritts, David C. University of Colorado, Boulder, Colorado. Correlative medium frequency radar studies of large-scale middle atmospheric dynamics in the Antarctic. OPP 93-19068. $131,555. (2)

Gaisser, Thomas K. Bartol Research Institute, Newark, Delaware. South Pole Air Shower Experiment–2. OPP 93-18754. $197,000. (2)

Gaisser, Thomas K. Bartol Research Institute, Newark, Delaware. South Pole Air Shower Experiment–2. OPP 96-40455. $12,550. (2)

Gaisser, Thomas K. Bartol Research Institute, Newark, Delaware. Acquisition of instrumentation for the South Pole Air Shower Experiment. OPP 96-01950. $28,480. ($105,000) (4)

Hall, Michael J. National Oceanic and Atmospheric Administration, Washington, DC. Support for Argos data collection and location system. OPP 96-42925. $467. ($638,651) (4)

Harper, Doyal A. University of Chicago, Chicago, Illinois. A Center for Astrophysical Research in Antarctica (CARA). OPP 96-28155. $3,730,000. ($3,930,000) (2)

Hernandez, Gonzalo J. University of Washington, Seattle, Washington. High-latitude antarctic neutral mesospheric and thermospheric dynamics and thermodynamics. OPP 93-16163. $130,000. (2)

Inan, Umran S. Stanford University, Stanford, California. Very-low-frequency remote sensing of thunderstorm and radiation belt coupling to the ionosphere. OPP 93-18596. $90,000 ($180,000) (1)

LaBelle, James W. Dartmouth College, Hanover, New Hampshire. Presidential Young Investigator Award. OPP 96-40381. $18,750. ($37,500) (2)

Lubin, Philip M. University of California, Santa Barbara, California. Studies of long-duration medium-scale cosmic background radiation anisotropy. OPP 95-44306. $30,000 (1)

Lubin, Philip M. University of California, Santa Barbara, California. University of California at Santa Barbara long-duration medium-scale cosmic background radiation anisotropy studies. OPP 96-43655. $13,500. (4)

Mende, Stephen B. University of California, Berkeley, California. Antarctic auroral imaging. OPP 96-16809. $32,000. (4)

Meyer, Stephan S. University of Chicago, Chicago, Illinois. Anisotropy of the cosmic microwave background radiation on large and medium angular scales. OPP 93-16535. $78,081. ($253,975) (2)

Meyer, Stephan S. University of Chicago, Chicago, Illinois. A Center for Astrophysical Research in Antarctica (CARA). OPP 96-43878. $26,700. (4)

Morse, Robert M. University of Wisconsin, Madison, Wisconsin. The Antarctic Muon and Neutrino Detection Array (AMANDA) Project: The antarctic ice sheet as a high-energy particle detector. OPP 95-44305. $150,000. (2)

Morse, Robert M. University of Wisconsin, Madison, Wisconsin. The Antarctic Muon and Neutrino Detector Array II (AMANDA-II) project. OPP 95-28559. $628,600. (4)

Murcray, Frank J. University of Denver, Denver, Colorado. Ground-based infrared measurements in Antarctica. OPP 95-26913. $34,992. ($69,992) (4)

Murcray, Frank J. University of Denver, Denver, Colorado. Ground-based infrared measurements in Antarctica. OPP 96-43089. $1. ($8,313) (4)

Murcray, Frank J. University of Denver, Denver, Colorado. Ground-based infrared measurements in Antarctica. OPP 96-43656. $5,000. (4)

Papen, George C. University of Illinois at Urbana–Champaign, Champaign, Illinois. Rayleigh and sodium lidar studies of the troposphere, stratosphere and mesosphere at the Amundsen–Scott South Pole Station. OPP 92-19898. $130,000. (2)

Papitashvili, Vladimir O. University of Michigan, Ann Arbor, Michigan. A study of very-high-latitude geomagnetic phenomena. OPP 93-18766. $160,000. (2)

Petit, Noel J. Augsburg College, Minneapolis, Minnesota. Automatic geophysical observatory (AGO) data support and distribution. OPP 92-19799. $27,891. (2)

Rosenberg, Theodore J. University of Maryland, College Park, Maryland. Riometry in Antarctica and conjugate regions. OPP 95-05823. $50,000. ($289,605) (2)

Rosenberg, Theodore J. University of Maryland, College Park, Maryland. Polar Experiment Network for Geophysical Upper-Atmosphere Investigations (PENGUIN). OPP 95-29177. $441,912. (4)

Rust, David M. Johns Hopkins University, Baltimore, Maryland. An optical investigation of the genesis of solar activity. OPP 95-44307. $68,567. ($137,133) (2)

Sivjee, Gulamabas G. Embry-Riddle Aeronautical University, Daytona Beach, Florida. Spectroscopic and interferometric studies of airglow and auroral processes in the antarctic upper atmosphere over the South Pole Station. OPP 96-40254. $12,440. (2)

Wilkes, R. Jeffrey. University of Washington, Seattle, Washington. Antarctic long-duration balloon flight for the Japanese-American cosmic ray emulsion chamber experiment (JACEE) collaboration. OPP 95-28397. $42,000. (4)

Glaciology

Albert, Mary R. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. Near-surface processes affecting gas exchange: West antarctic ice sheet. OPP 95-26601. $50,138. (4)

Alley, Richard B. Pennsylvania State University, University Park, Pennsylvania. Continuation of antarctic ice-sheet stability on a deforming bed: Model studies. OPP 93-18677. $80,945. (2)

Alley, Richard B. Pennsylvania State University, University Park, Pennsylvania. Physical properties of the Siple Dome deep ice core. OPP 95-26374. $3,791. (2)

Anandakrishnan, Sridhar. Pennsylvania State University, University Park, Pennsylvania. Microearthquake monitoring of ice stream C, West Antarctica: A sensor for sticky spots. OPP 96-40018. $5,138 (1)

Anandakrishnan, Sridhar. Pennsylvania State University, University Park, Pennsylvania. Microearthquake monitoring of ice stream C, West Antarctica: A sensor for sticky spots. OPP 93-18121. $105,119. (2)

Baker, Ian. Dartmouth College, Hanover, New Hampshire. Conference: International Symposium on the Physics and Chemistry of Ice, Hanover, New Hampshire, 26–30 August 1996. OPP 95-30356. $3,300 ($10,000) (1)

Baker, Ian. Dartmouth College, Hanover, New Hampshire. Flow and fracture of ice. OPP 95-26454. $85,000. (2)

Baker, Ian. Dartmouth College, Hanover, New Hampshire. Flow and fracture of ice. OPP 96-43149. $7,300. (4)

Bales, Roger C. University of Arizona, Tucson, Arizona. Snow-atmosphere transfer function for reversibly deposited chemical species in West Antarctica. OPP 95-26572. $220,475. (4)

Bender, Michael L. University of Rhode Island, Kingston, Rhode Island. Climate studies using antarctic deep ice cores and firn air samples. OPP 95-26740. $135,392. (2)

Bender, Michael L. University of Rhode Island, Kingston, Rhode Island. Climate studies using antarctic deep-ice cores and firn air samples. OPP 96-43504. $5,861. (4)

Bentley, Charles R. University of Wisconsin, Madison, Wisconsin. An examination of the dynamic stability of the west antarctic ice sheet by numerical modeling. OPP 95-27044. $99,995. (2)

Bentley, Charles R. University of Wisconsin, Madison, Wisconsin. Airborne radar sounding over ice stream D, West Antarctica. OPP 93-19043. $112,749. (4)

Berkman, Paul A. Ohio State University, Columbus, Ohio. Holocene environmental variability associated with west antarctic ice-sheet retreat along the Victoria Land coast. OPP 96-40178. $13,591 (1)

Bindschadler, Robert A. National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Maryland. Passive microwave remote sensing for paleoclimate indicators at Siple Dome, Antarctica. OPP 95-26566. $140,143. (2)

Bindschadler, Robert A. National Aeronautics and Space Administration, Goddard Space Flight Center. Greenbelt, Maryland. West antarctic glaciology–IV. OPP 96-41628. $200,000. (3)

Bindschadler, Robert A. National Aeronautics and Space Administration, Goddard Space Flight Center. Greenbelt, Maryland. Workshops for the west antarctic ice sheet project. OPP 96-34698. $7,101. ($14,201) (3)

Biscaye, Pierre E. Columbia University, New York, New York. Atmospheric dust in west antarctic ice: WAISCORES (west antarctic ice sheet cores). OPP 95-26973. $80,000. (2)

Blankenship, Donald D. University of Texas, Austin, Texas. Lithospheric controls on the behavior of the west antarctic ice sheet: Aerogeophysics of the eastern Ross Transect Zone. OPP 93-19369. $175,000. ($177,076) (4)

Blankenship, Donald D. University of Texas, Austin, Texas. Support Office for Aerogeophysical Research (SOAR). OPP 96-43423. $22,600. ($1,043,703) (4)

Braaten, David A. University of Kansas, Lawrence, Kansas. Measurements and model development of antarctic snow accumulation and transport dynamics. OPP 96-42853. $1,110. ($6,841) (4)

Chin, Yu-Ping. Ohio State University, Columbus, Ohio. The effect of dissolved organic matter on the photolysis and bioaccumulation of synthetic organic compounds in two lakes on Ross Island, Antarctica. OPP 96-16287. $908. ($50,067) (4)

Denton, George H. University of Maine, Orono, Maine. Sensitivity of the antarctic ice sheet to Late Quaternary climate change. OPP 96-40498. $22,158. (2)

Denton, George H. University of Maine, Orono, Maine. The origin of a polar ice sheet in East Antarctica. OPP 95-27047. $85,616. (3)

Dunbar, Nelia W. New Mexico Institute of Mining and Technology. Socorro, New Mexico. Volcanic record in antarctic ice: Implications for climatic and eruptive history and ice-sheet dynamics of the south polar region. OPP 95-27373. $80,475. (3)

Fastook, James L. University of Maine, Orono, Maine. Derived quantities: A coupled dynamic/thermodynamic ice-sheet model. OPP 95-26348. $90,519. (2)

Faure, Gunter. Ohio State University, Columbus, Ohio. Age of the last transgression of the east antarctic ice sheet, Transantarctic Mountains, southern Victoria Land. OPP 93-16310. $13,460. ($26,913) (3)

Friedmann, E. Imre. Florida State University, Tallahassee, Florida. Living and fossil microorganisms, a sensitive paleoclimate indicator in the McMurdo Dry Valleys: Implications for Plio-Pleistocene climate and ice sheet. OPP 94-20227. $59,976. (3)

Gow, Anthony J. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. Physical and structural properties of the Siple Dome core. OPP 95-27262. $11,516. (3)

Hall, Michael J. National Oceanic and Atmospheric Administration, Washington, DC. Support for Argos data collection and location system. OPP 96-42925. $1,850. ($638,651) (4)

Harwood, David M. University of Nebraska, Lincoln, Nebraska. Presidential Young Investigator Award. OPP 96-43867. $37,500. (4)

Jacobel, Robert W. Saint Olaf College, Northfield, Minnesota. Siple Dome glaciology and ice stream history. OPP 93-16338. $104,982. (2)

Jacobel, Robert W. Saint Olaf College, Northfield, Minnesota. Ice-radar and satellite remote-sensing studies of glaciers and ice sheets–II. OPP 95-31501. $15,075. ($30,150) (3)

Kamb, Barclay. California Institute of Technology, Pasadena, California. Fast flow of antarctic ice streams—Bed deformation or basal sliding? Borehole study of Ice Streams B and C. OPP 93-19018. $225,419. ($476,803) (4)

Kurz, Mark D. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Pliocene history of the east antarctic ice sheet: A workshop. OPP 96-40004. $2,150 ($4,300) (1)

Kurz, Mark D. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Chronology of antarctic glaciations. OPP 94-18333. $131,364. (2)

Mahaffy, Mary-Anne W. Pennsylvania State University, University Park, Pennsylvania. Sensitivity study of processes pertaining to the ice dynamics of the west antarctic ice sheet using a three-dimensional time-dependent whole-ice-sheet model. OPP 94-18622. $62,856. (4)

Mayewski, Paul A. University of New Hampshire, Durham, New Hampshire. Ross ice drainage system (RIDS) Late Holocene climate variability. OPP 93-16564. $151,015. (3)

Mayewski, Paul A. University of New Hampshire, Durham, New Hampshire. Siple Dome deep ice core glaciochemistry and regional survey—A contribution to the west antarctic ice sheet initiative. OPP 95-26449. $52,368. ($62,368) (3)

Mosley-Thompson, Ellen. Ohio State University, Columbus, Ohio. The quantitative assessment of the Mount Pinatubo signal in antarctic snow. OPP 95-26725. $52,423. (2)

Mosley-Thompson, Ellen. Ohio State University, Columbus, Ohio. Holocene/Late Wisconsinan dust history from Taylor Dome, Antarctica. OPP 93-16282. $44,369. (3)

Mosley-Thompson, Ellen. Ohio State University, Columbus, Ohio. Long-term trend in net mass accumulation at South Pole. OPP 91-17447. $33,375. (3)

Prentice, Michael L. University of New Hampshire, Durham, New Hampshire. An inventory of environmental features in the McMurdo Dry Valleys, Antarctica, and their recent changes using a geographic information system. OPP 96-27625. $3,733. ($296,968) (4)

Prentice, Michael L. University of New Hampshire, Durham, New Hampshire. Holocene environmental variability associated with the west antarctic ice sheet along the Victoria Land coast. OPP 96-43150. $5,400. (4)

Raymond, Charles F. University of Washington, Seattle, Washington. Origin and implications of small-scale surface topography on Siple Coast ice streams. OPP 95-26707. $42,328. (2)

Raymond, Charles F. University of Washington, Seattle, Washington. Siple Dome glaciology and ice-stream history. OPP 93-16807. $107,961. (3)

Saltzman, Eric S. University of Miami, Rosentiel School of Marine and Atmospheric Sciences, Miami, Florida. Antarctic ice core records. OPP 95-26952. $120,000. (3)

Scambos, Theodore A. University of Colorado, Boulder, Colorado. Siple Dome glaciology and ice-stream history. OPP 93-17007. $25,732. (3)

Sowers, Todd. Pennsylvania State University, University Park, Pennsylvania. Constructing paleoatmospheric records of the isotopic composition of methane and nitrous oxide. OPP 95-26556. $190,006. ($285,006) (3)

Taylor, Kendrick C. University of Nevada Desert Research Institution, Reno, Nevada. Electrical and optical measurements on the Siple Dome ice core. OPP 95-26420. $9,176. (2)

Taylor, Kendrick C. University of Nevada, Desert Research Institute, Reno, Nevada. Recovery and science coordination of an ice core at Siple Dome, Antarctica. OPP 95-26421. $154,701. (3)

Thonnard, Norbert. University of Tennessee, Knoxville, Tennessee. Development of laser-based resonance ionization spectroscopy techniques for krypton-81 and krypton-85 measurements in the geosciences. OPP 94-10695. $15,000. ($96,848) (3)

Waddington, Edwin D. University of Washington, Seattle, Washington. Analysis of existing geophysical data from Taylor Dome for ice core interpretation and relation to the dry valleys geomorphological climate record. OPP 94-21644. $77,742. (3)

Waddington, Edwin D. University of Washington, Seattle, Washington. Ice modeling study of Siple Dome: West antarctic ice sheet ice dynamics, WAISCORES (west antarctic ice sheet cores) paleoclimate and ice-stream/ice-dome interactions. OPP 94-20648. $78,258. (3)

Ware, Randolph H. University Center for Atmospheric Research, Boulder, Colorado. Support of UNAVCO and related activities. OPP 96-40521. $25,000. ($1,242,037) (2)

Whillans, Ian M. Ohio State University, Columbus, Ohio. Mass balance and ice-stream mechanics in West Antarctica. OPP 93-16509. $130,889. (3)

White, James W. University of Colorado, Boulder, Colorado. Isotopic measurements on the west antarctic ice sheet/Siple Dome ice cores. OPP 95-26979. $65,000. (2)

White, James W. University of Colorado, Boulder, Colorado. Stable isotope measurements on shallow cores from West Antarctica. OPP 94-18642. $53,405. (2)

White, James W. University of Colorado, Boulder, Colorado. National Ice Core Curatorial Facility. OPP 96-41126. $77,351. (3)

Wilson, Gary S. Ohio State University, Columbus, Ohio. The use of fossil microorganisms for the study of ancient climates in the McMurdo Dry Valleys. OPP 96-40131. $8,176 (1)

Wilson, Gary S. Ohio State University, Columbus, Ohio. Mount Feather Sirius Group workshop and collaborative sample analysis and publication. OPP 96-34644. $10,867. ($21,735) (3)

Zielinski, Gregory A. University of New Hampshire, Durham, New Hampshire. Volcanic record in antarctic ice: Implications for climatic and eruptive history and ice-sheet dynamics of the south polar region. OPP 95-27824. $30,052. (3)

Environmental research

Chin, Yu-Ping. Ohio State University, Columbus, Ohio. The effect of dissolved organic matter on the photolysis and bioaccumulation of synthetic organic compounds in two lakes on Ross Island, Antarctica. OPP 96-16287. $40,159. ($50,067) (4)

Fauchald, Kristian. Smithsonian Institution, Washington, DC. Biological collections from polar regions. OPP 95-09761. $100,000 ($500,000) (1)

Fraser, William R. Montana State University, Bozeman, Montana. Changes in Adélie penguin populations at Palmer Station: The effects of human disturbance and long-term environmental change. OPP 95-05596. $109,911. (4)

Hansen, Anthony D. Magee Scientific Company, Berkeley, California. Measurement of combustion effluent aerosols from the South Pole Station. OPP 95-30428. $1,500. (4)

Naveen, Ron. Oceanites, Inc., Cooksville, Maryland. Antarctic site inventory and monitoring program. OPP 96-42732. $2,500. (4)

Oliver, John S. San Jose State University, San Jose, California. Entry of sewage-derived organic matter from McMurdo Station, Antarctica, into the benthic food web and its biological consequences. OPP 95-27789. $0. ($124,531) (4)

Prentice, Michael L. University of New Hampshire, Durham, New Hampshire. An inventory of environmental features in the McMurdo Dry Valleys, Antarctica, and their recent changes using a geographic information system. OPP 96-27625. $190,679. ($296,968) (4)

Services and support

Abbott, Mark R. Oregon State University, Corvallis, Oregon. Mesoscale processes and primary productivity at the polar front. OPP 95-30507. $200,000. ($360,000) (4)

Andrews, Martha. University of Colorado, Boulder, Colorado. A user-based polar information system: Coordinating responsibilities through the U.S. Polar Information Working Group. OPP 93-21320. $10,423. ($20,847) (3)

Blaisdell, George. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. Technical support for the U.S. Antarctic Program. OPP 95-43409. $151,369 (1)

Blaisdell, George. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. Technical support for the U.S. Antarctic Program. OPP 96-40160. $419,138 (1)

Blaisdell, George. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. Technical support for the U.S. Antarctic Program. OPP 96-43795. $30,000. (4)

Blankenship, Donald D. University of Texas, Austin, Texas. Support Office for Aerogeophysical Research (SOAR). OPP 96-43423. $287,200. ($1,043,703) (4)

Blankenship, Donald D. University of Texas, Austin, Texas. Support Office for Aerogeophysical Research (SOAR). OPP 96-43423. $400,000. ($1,043,703) (4)

Britton, Mark C. Andrulis Research Corp, Arlington, Virginia. Web page and programming support (OPP). OPP 96-17255. $39,974. (4)

Bronk, Deborah A. University of Georgia, Athens, Georgia. New and regenerated production in the southern oceans: Ross Sea studies. OPP 96-43869. $7,280. ($34,978) (4)

Brown, Otis B. University of Miami, Miami, Florida. Satellite communications for scientific purposes: University National Oceanographic Laboratory System (UNOLS) fleet management and polar program support. OPP 96-43528. $149,523. (4)

Currier, Stephen F. National Aeronautics and Space Administration, Wallops Island, Virginia. Operations of the NASA-NSF McMurdo ground station. OPP 96-28886. $291,345. (4)

Elfring, Chris. National Academy of Sciences, Washington, DC. Core support for the Polar Research Board. OPP 96-33478. $80,200. ($160,400) (4)

Elliott, Harold T. Navy-Military Sealift Command, Washington, DC. U.S. Antarctic Program fuel tanker support. OPP 96-16357. $2,360,800. (4)

Fauchald, Kristian. Smithsonian Institution, Washington, DC. Biological collections from polar regions. OPP 96-43726. $187,200. ($213,467) (4)

Fowler, Alfred N. American Geophysical Union, Washington, DC. Council of Managers of National Antarctic Programs Secretariat. OPP 93-21509. $65,771. (2)

Gaisser, Thomas K. Bartol Research Institute, Newark, Delaware. Acquisition of instrumentation for the South Pole Air Shower Experiment. OPP 96-01950. $37,200. ($105,000) (4)

Givan, May Beth. Department of Health and Human Services, Washington, DC. Industrial and environmental hygiene services. OPP 95-43466. $45,253 (1)

Givan, May Beth. Department of Health and Human Services, Washington, DC. Industrial and environmental hygiene services. OPP 96-40214. $33,219. (2)

Givan, May Beth. Department of Health and Human Services, Washington, DC. Industrial and environmental hygiene services. OPP 96-42108. $50,000. (4)

Givan, May Beth. Department of Health and Human Services, Washington, DC. Industrial and environmental hygiene services. OPP 96-43796. $80,000. (4)

Hall, Michael J. National Oceanic and Atmospheric Administration, Washington, DC. Support for Argos data collection and location system. OPP 96-42925. $47,755. ($638,651) (4)

Hamilton, Gordon S. Ohio State University, Columbus, Ohio. Investigation of a step feature near the skiway on McMurdo Ice Shelf, Antarctica. OPP 95-28608. $38,929 (1)

Hibben, Stuart G. Library of Congress, Washington, DC. Abstracting and indexing service for *Current antarctic literature*. OPP 96-40779. $287,003. (3)

Kamb, Barclay. California Institute of Technology, Pasadena, California. Fast flow of antarctic ice streams—Bed deformation or basal sliding? Borehole study of ice streams B and C. OPP 93-19018. $251,384. ($476,803) (4)

Kennicutt, Mahlon C. Texas A&M University, College Station, Texas. International workshops on environmental monitoring in Antarctica. OPP 95-29958. $66,587. (2)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 95-44138. $9,973,037 ($10,130,714) (1)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 95-44325. $241,219 (1)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-40283. $15,000,000 (1)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-40584. $25,500,000. ($25,503,771) (2)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-40908. $14,000,000. (2)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-41407. $7,000,000. ($7,021,000) (3)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-42445. $2,600,000. ($17,605,200) (4)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-42445. $15,000,000. ($17,605,200) (4)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-43915. $58,733. ($12,890,867) (4)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-43915. $870,000. ($12,890,867) (4)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-43915. $9,428,958. ($12,890,867) (4)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-43915. $2,310,375. ($12,890,867) (4)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-43915. $24,300. ($12,890,867) (4)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 96-44010. $14,962. ($65,423) (4)

Kuivinen, Karl C. University of Nebraska, Lincoln, Nebraska. Logistic and engineering support by the Polar Ice Coring Office. OPP 96-40035. $1,551,582. ($1,851,582) (2)

Kvitek, Rikk G. San Jose State University, San Jose, California. Hydrographic survey and geographic information system database development for anthropogenic debris and marine habitats at McMurdo Station, Antarctica. OPP 96-43151. $30,000. ($51,532) (4)

Kvitek, Rikk G. San Jose State University, San Jose, California. Hydrographic survey and geographic information system database development for anthropogenic debris and marine habitats at McMurdo Station, Antarctica. OPP 96-43151. $21,532. ($51,532) (4)

Lewis, Michael R. Jackson and Tull Chartered, Washington, DC. Communication and engineering support services for the U.S. Antarctic Program. OPP 95-44185. $135,000 (1)

Lewis, Michael R. Jackson and Tull Chartered, Washington, DC. Communication and engineering support services for the U.S. Antarctic Program. OPP 96-41483. $172,599. (3)

Lewis, Michael R. Jackson and Tull Chartered, Washington, DC. Communication and engineering support services for the U.S. Antarctic Program. OPP 96-43936. $81,815. (4)

Lowenthal, Douglas H. University of Nevada, Desert Research Institute, Reno, Nevada. Particulate matter less than 10 microns in size (PM10) source apportionment at McMurdo Station, Antarctica. OPP 95-44154. $145,000 ($147,856) (1)

Lubin, Dan. Scripps Institution of Oceanography, La Jolla, California. The Arctic and Antarctic Research Center: A unique resource for polar science and operations. OPP 94-14276. $140,000. (4)

Nelson, Marilyn. Blue Pencil Group, Inc., Reston, Virginia. Editorial services for the *Antarctic Journal of the United States*. OPP 96-43335. $34,713. ($46,372) (4)

Nelson, Marilyn. Blue Pencil Group, Inc., Reston, Virginia. Editorial services for the *Antarctic Journal of the United States*. OPP 96-43335. $11,659. ($46,372) (4)

Onuma, Tsuyoshi. Navy Facilities and Engineering Command, Arlington, Virginia. Engineering support for the U.S. Antarctic Program. OPP 96-40140. $1,275,000 (1)

Onuma, Tsuyoshi. Navy Facilities and Engineering Command, Arlington, Virginia. Engineering support for the U.S. Antarctic Program. OPP 96-43240. $235,000. (4)

Prentice, Michael L. University of New Hampshire, Durham, New Hampshire. An inventory of environmental features in the McMurdo Dry Valleys, Antarctica, and their recent changes using a geographic information system. OPP 96-27625. $81,805. ($296,968) (4)

Rounds, Fred. National Aeronautics and Space Administration, Washington, DC. Internet telecommunications support for the U.S. Antarctic Program. OPP 96-43686. $25,000. (4)

Rummel, John D. National Aeronautics and Space Administration, Washington, DC. National Science Foundation/National Aeronautics and Space Administration technology demonstration. OPP 95-43531. $250,000 (1)

Scharfen, Gregory R. University of Colorado, Boulder, Colorado. U.S. Antarctic Data Coordination Center at the National Snow and Ice Data Center. OPP 96-29768. $63,504. (4)

Schommer, John. Department of Interior, Washington, DC. Aviation Management Services. OPP 96-43291. $4,910,837. (4)

Shah, Raj N. Capital Systems Group, Inc., Rockville, Maryland. Proposal processing and travel support to the Office of Polar Programs, National Science Foundation. OPP 95-42446. $41,402 (1)

Shah, Raj N. Capital Systems Group, Inc., Rockville, Maryland. Proposal processing and travel support to the Office of Polar Programs, National Science Foundation. OPP 95-43489. $8,269 (1)

Shah, Raj N. Capital Systems Group, Inc., Rockville, Maryland. Proposal processing and travel support to the Office of Polar Programs, National Science Foundation. OPP 95-43522. $10,345 (1)

Shah, Raj N. Capital Systems Group, Inc., Rockville, Maryland. Proposal processing and travel support to the Office of Polar Programs, National Science Foundation. OPP 95-43803. $105,804 (1)

Shah, Raj N. Capital Systems Group, Inc., Rockville, Maryland. Proposal processing and travel support to the Office of Polar Programs, National Science Foundation. OPP 96-40344. $15,622. (2)

Shah, Raj N. Capital Systems Group, Inc., Rockville, Maryland. Proposal processing and travel support to the Office of Polar Programs, National Science Foundation. OPP 96-40414. $86,363. (2)

Shah, Raj N. Capital Systems Group, Inc., Rockville, Maryland. Proposal processing and travel support to the Office of Polar Programs, National Science Foundation. OPP 96-43757. $10,948. (4)

Shah, Raj N. Capital Systems Group, Inc., Rockville, Maryland. Proposal processing and travel support to the Office of Polar Programs, National Science Foundation. OPP 96-43098. $3,609. (4)

Shah, Raj N. Capital Systems Group, Inc., Rockville, Maryland. Proposal processing and travel support to the Office of Polar Programs, National Science Foundation. OPP 96-43560. $98,140. (4)

Shah, Raj N. Capital Systems Group, Inc., Rockville, Maryland. Proposal processing and travel support to the Office of Polar Programs, National Science Foundation. OPP 96-43712. $36,331. (4)

Shah, Raj N. Capital Systems Group, Inc., Rockville, Maryland. Proposal processing and travel support to the Office of Polar Programs, National Science Foundation. OPP 96-43897. $4,940. (4)

Sloan, William M. Northeast Industrial Waste, Annapolis, Maryland. Technology transfer to the Small Communities Antarctic Waste Management Program. OPP 96-32915. $48,647. (4)

Smith, Charles H. Department of Defense, Washington, DC. Logistic support of the U.S. program in Antarctica. OPP 96-40187. $12,000,000 (1)

Smith, Charles H. Department of Defense, Washington, DC. Logistic Support of the U.S. program in Antarctica. OPP 96-40907. $11,500,000. (2)

Smith, Charles H. Department of Defense, Washington, DC. Logistic support of the U.S. program in Antarctica. OPP 96-41457. $6,000,000. (3)

Smith, Charles H. Department of Defense, Washington, DC. Logistic support of the U.S. program in Antarctica. OPP 96-42496. $10,500,000. (3)

Smith, Charles H. Department of Defense, Washington, DC. Logistic support of the U.S. program in Antarctica. OPP 96-43769. $7,912,625. (4)

Smith, Steven. International Center for Antarctic Information, New Zealand. Preparation of management plans for Antarctic Specially Managed Areas. OPP 95-28775. $68,853. (3)

Smith, Steven. International Center for Antarctic Information, Christchurch, New Zealand. Preparation of management plans for antarctic Specially Managed Areas. OPP 96-43266. $43,907. (4)

Smith, Steven. International Center for Antarctic Information, Christchurch, New Zealand. Antarctic master directory. OPP 96-15205. $59,613. (4)

Sokolov, Barbara J. University of Alaska, Anchorage, Alaska. Polar libraries colloquy: Proceedings and participant support. OPP 96-27353. $7,000. ($25,329) (3)

Spilhaus, A.F. American Geophysical Union, Washington, DC. Publication of *Antarctic research series*. OPP 94-14962. $66,258. (2)

Sutherland, Woody C. Scripps Institution of Oceanography, La Jolla, California. Shipboard technicians support. OPP 94-00707. $15,698. ($875,666) (3)

Swenson, Emily B. Children's Television Workshop, New York, New York. "3-2-1 Contact" distribution and utilization. OPP 95-44189. $25,000 ($49,917) (1)

Taylor, Susan. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. Retrieval and analysis of extraterrestrial particles from the water well at the Amundsen–Scott South Pole Station, Antarctica. OPP 95-44300. $21,256 (1)

Walker, Alan. Department of Transportation, U.S. Coast Guard, Washington, DC. Icebreaker support in the U.S. Antarctic Program. OPP 96-42478. $1,996,234. (4)

Ware, Randolph H. University Center for Atmospheric Research, Boulder, Colorado. Support of UNAVCO and related activities. OPP 96-40521. $70,000. ($1,242,037) (2)

Wharton, Robert A. University of Nevada, Desert Research Institute, Reno, Nevada. Workshop on environmental management of the McMurdo Dry Valleys of Antarctica, 14–17 March 1995, Santa Fe, New Mexico. OPP 96-41224. $25,006. (3)

Weber, Gary. Petroleum Helicopters, Inc., Lafayette, Louisiana. Helicopter services for the U.S. Antarctic Program. OPP 96-16400. $1. (4)

Witmer, Richard E. U.S. Geological Survey, Reston, Virginia. Antarctic surveying and mapping program. OPP 96-43361. $87,200. ($335,600) (4)

Witmer, Richard E. U.S. Geological Survey, Reston, Virginia. Antarctic surveying and mapping program. OPP 96-43361. $30,600. ($335,600) (4)

Wratt, Gillian. New Zealand Antarctic Program, Christchurch, New Zealand. Cape Roberts project. OPP 96-40063. $200,000 (1)