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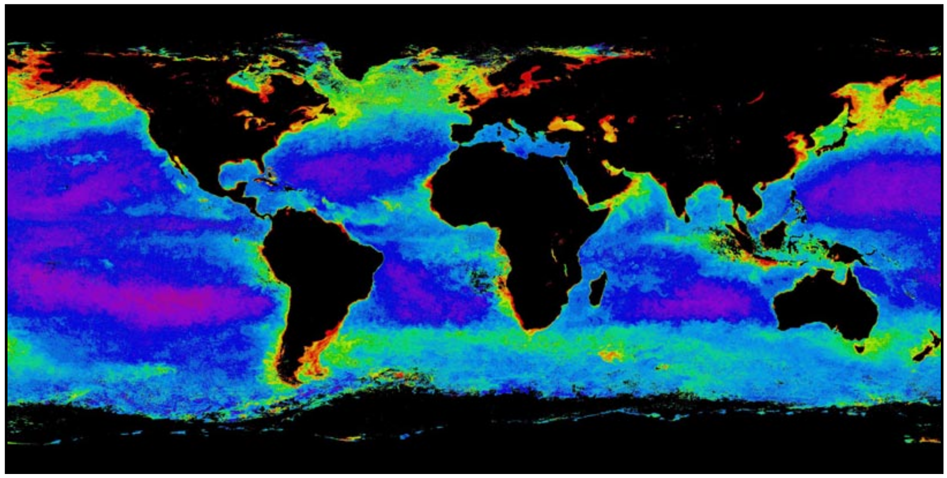

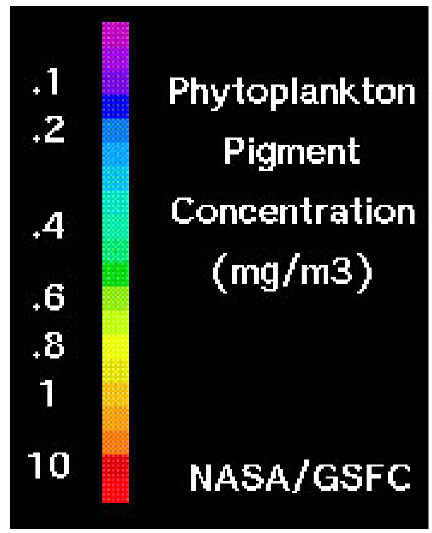

Carried aboard the SeaStar spacecraft, the new orbiting satellite instrument SeaWiFS (the Sea-viewing Wide Field-of-view Sensor Project), views every square kilometer of cloud-free ocean every 48 hours. With each pass, it charts ocean color, which enables it to quantify the concentration of microscopic marine plants called *phytoplankton*. The color in most of the world's oceans varies with the concentration of chlorophyll and other plant pigments in the water—the more phytoplankton present, the greater the concentration of plant pigments and the greener the water. By charting water color against the Coastal Zone Color Scanner (CZCS), shown in the key with the image, SeaWiFS can derive chlorophyll concentrations and from them determine phytoplankton concentrations. The oceanographic community uses these data about the abundance of phytoplankton and other primary producers—that is, the algae and bacteria at the bottom of the food chain that use sunlight and chemicals, rather than other organic material, as sources of energy—to study ocean processes on a global scale. The information can also be used to assess the ocean's role in the global carbon cycle and the exchange of other critical elements and gases between the atmosphere and the ocean. The SeaWiFS mission is part of the National Aeronautics and Space Administration's "Mission to Planet Earth" project, whose goal is to help scientists and researchers gain understanding of the Earth as a functioning system by viewing it from space. (Image provided by the SeaWiFS Project, NASA/Goddard Space Flight Center.)

THE National Science Foundation (NSF) provides awards for research and education in the sciences and engineering. The awardee is wholly responsible for the conduct of such research and preparation of the

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The *Antarctic Journal* is a medium for information about, and related to, the U.S. Antarctic Program. NSF welcomes ideas for improvement. Send comments to Winifred Reuning at *WReuning@nsf.gov* (e-mail) or Editor, Antarctic Journal, Office of Polar Programs, National Science Foundation, 4201 Wilson Boulevard, Arlington, Virginia 22230 (703-306-1033).

The *Antarctic Journal* invites contributions from members of the antarctic science, logistics, and policy communities who want to communicate their work and ideas to an audience of specialists and scientifically literate nonspecialists. The *Antarctic Journal* is not peer reviewed. It provides reports on U.S. activities in Antarctica and related activities elsewhere and on trends in the U.S. Antarctic Program. The September 1997 online issue contains author guidelines for submitting manuscripts to the review issue, as well as information about submitting materials for the monthly online issues.

U.S. Antarctic Program news

Upcoming deadlines for special funding opportunities

SCIENTISTS are reminded that deadlines for a number of National Science Foundation cross-directorate or other special funding opportunities that should be of interest to the polar community are approaching. The table lists each of these National Science Foundation programs and the associated deadlines.

National Science Foundation programs and deadlines

Funding opportunity	Deadlines
Life in Extreme Environments (LExEN) for FY-98 (NSF 97-157)	Proposals: 15 January 1998
Science and Technology Centers (STC; NSF 98-13)	Proposals: 12 February 1998[a] Full proposals: 3 September 1998
Earth System History (NSF 97-161)	Proposals: 15 January 1998
Major Research Instrumentation (NSF 98-16)	Proposals: 30 January 1998
A Possible Antarctic Geological Repository (NSF 97-156)	Letters of interest: 1 February 1998

[a]Before submitting a proposal, interested researchers were required to submit a "notice of intent" by 6 January 1998.

Penhale to receive 1998 AGU Ocean Sciences Award

IN recognition of her success and dedication in building and maintaining a high-quality, balanced polar science program, Polly A. Penhale, program manager for the National Science Foundation's (NSF) Antarctic Biology and Medicine Program, will receive the American Geophysical Union's (AGU) 1998 Ocean Sciences Award in February 1998 at the AGU Ocean Sciences Meeting in San Diego, California. The award is made in recognition of excellence and lasting contributions to ocean sciences.

As a science administrator, Dr. Penhale has developed a research program that includes not only diverse single-investigator projects but also large, multidisciplinary projects, some of which are international in scope. Under her management the traditional single-investigator portion of the polar biology and medicine program has become a competitive but balanced program, embracing the diverse constituencies in the biology and medicine communities. This is exemplified in the results of a recent study that found that if the biology and medicine program did not exist, proposals would be distributed among 31 different NSF programs. Through her efforts, the U.S. Antarctic Program has become an active component of such important international projects as the Joint Global Ocean Flux Study and the Global Ocean Ecosystem Dynamics program. She has also taken an active role in the organizations that provide scientific input to the Antarctic Treaty system. These activities demonstrate her commitment to protecting and preserving the unique environment of the antarctic region.

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Global climate change recorded in antarctic marine fossils

Science notebook—News from Antarctica and beyond

New satellite image guides ship operations

WHILE working in the Ross Sea, the R/V *Nathaniel B. Palmer* received a surprising image from a new National Aeronautics and Space Administration (NASA) satellite called SeaWiFs. The image, which revealed dramatic and unexpected mesoscale variations in pigment concentrations of the southern Ross Sea, presented researchers aboard the *Palmer* with a serendipitous opportunity to study the processes and conditions associated with the formation of high-chlorophyll features in the Ross Sea and to gather *in situ* information that could be used to improve algorithms used to construct models of pigment concentrations. On the basis of the image, biologist Walker O. Smith, Jr., (University of Tennessee–Knoxville) and his team from the Antarctic Environment and Southern Ocean Process Study (AESOPS) decided to change the cruise schedule to allow 2 days of sampling of the feature.

The SeaWiFs satellite, launched last summer, is still undergoing testing, but it is already returning impressive and valuable images from the world's oceans. For the past 2–3 months, personnel from NASA's Goddard Space Flight Center, the Scripps Institution of Oceanography, and the National Science Foundation's support contractor, Antarctic Support Associates, have worked to set up a system to collect, process, and transmit SeaWiFs images to AESOPS cruises—a system that promises to become widely used in the future. Employing satellite images to guide studies represents an exciting new tool that can help scientists zero in on important ocean phenomena and can enable researchers, especially those in remote areas, to use limited field time effectively.

Global climate change recorded in antarctic marine fossils

AN ancient type of marine community typical of those found 450 million years ago has been discovered in antarctic fossils of near-modern age. A National Science Foundation-sponsored expedition to Seymour Island off the Antarctic Peninsula unearthed an ecological anomaly: fossil communities only 40 million years old dominated by brittle stars and sea lilies (marine invertebrates like starfish).

In a paper detailing the findings, published in the October 1997 issue of the journal *Geology*, Richard Aronson and his coauthors contend that as Antarctica entered its current cold phase, cooling ocean temperatures suppressed predation and spurred a dramatic increase in nutrients upwelling in the southern oceans surrounding the continent. "This discovery is a good example of how global climate change can have severe impacts on marine life," commented Aronson, senior marine scientist at Dauphin Island Sea Lab.

The comparative numbers of different organisms occupying particular ecological niches—that is, the community structure—reflected in the Seymour Island fossils unearthed by Aronson and his team was much more typical of the shallow seas of 150 to 450 million years ago. After that, predation by newly evolved fish

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and other creatures confined brittle stars and sea lilies to deep-sea habitats. Aronson and his coauthors believe that when antarctic temperatures began to plummet, however, predation was disrupted—some predator populations shrank and others became extinct—and the archaic community structure reappeared. In fact, the brittle stars and sea lilies that are clustered in dense beds of fossils show few arm injuries, an indication that predation was light.

Bottom dwellers such as brittle stars and sea lilies require abundant nutrients. According to the authors, global cooling accelerated about 40 million years ago in the late Eocene, and this long-term trend was accompanied by increased upwelling in the southern oceans, including around the Antarctic Peninsula, and more nutrients became available. The authors also point out that today, living bottom-dwelling communities in antarctic waters also show archaic characteristics. They suggest that perhaps conditions in the Antarctic or in the southern oceans generally work in some way to maintain these old-fashioned community structures.

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Southern Coats Land nunataks

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Initial results of geologic investigations in the Shackleton Range and southern Coats Land nunataks, Antarctica

Frederick E. Hutson, Mark A. Helper, Ian W.D. Dalziel, and Stephen W. Grimes, Department of Geological Sciences and Institute for Geophysics, University of Texas, Austin, Texas 78712

We present here initial results of geologic investigations conducted during the 1993–1994 field season in the Shackleton Range and the southern Coats Land nunataks (Dalziel et al. 1994) (figure 1). The major goal of this study is to test the "SWEAT" (Southwest U.S.–East Antarctica) hypothesis, which proposes that Laurentia and East Antarctica–Australia were juxtaposed in the Proterozoic and formed part of the supercontinent, Rodinia (Dalziel 1991; Moores 1991). The SWEAT hypothesis suggests that the approximately 1.0-billion-year-old rocks of the southern Coats Land nunataks are a continuation of the 1.0- to 1.3-billion-year-old Grenville Province of North America and that approximately 1.6- to 1.8-billion-year-old rocks of the Yavapi/Mazatzal Province in the southwestern U.S. are correlative with broadly similar-age rocks in the Shackleton Range. We are examining the hypothesis by

- comparing the igneous rocks of the southern Coats Land nunataks and basement rocks of the Shackleton Range with their proposed equivalents in the southwestern U.S.;

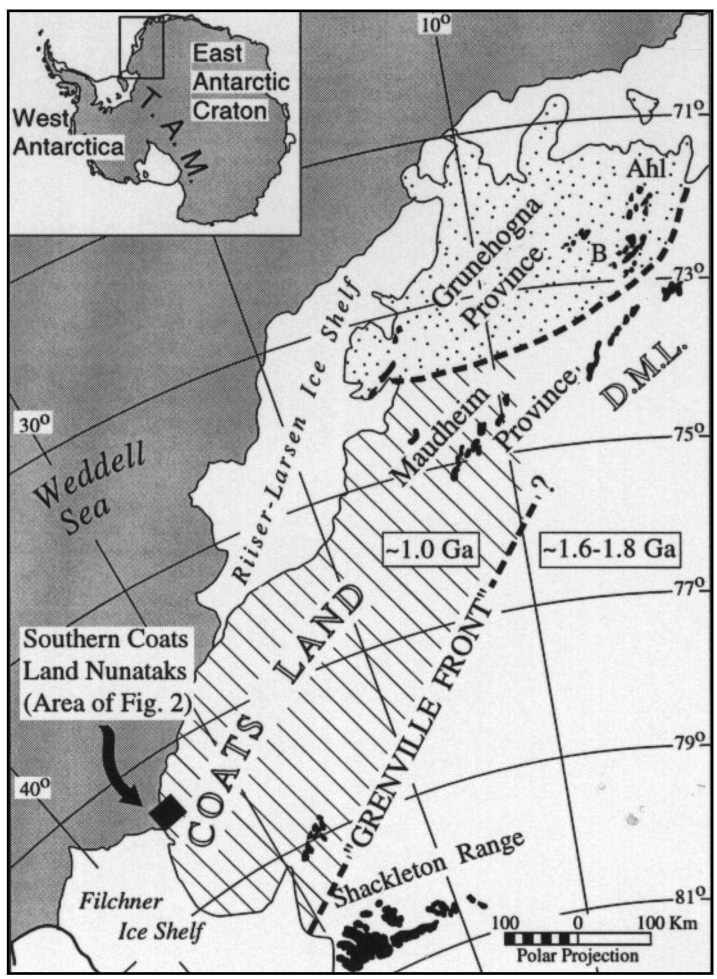

Figure 1. Map of the Weddell Sea margin of the east antarctic Precambrian craton (see inset), showing location of the "Grenville Front," as suggested by Dalziel (1992), the Maudheim and Grunehogna Provinces (from Moyes, Barton, and Groenewald 1993), the Shackleton Range, and the location of the southern Coats Land nunataks. Generalized areas of rock exposure are shown in black. Abbreviations: Ahl, Ahlmannryggen; B, Borgmassivet; D.L.M., Queen (Dronning) Maud Land; T.A.M., Transantarctic Mountains (after Gose et al. 1997). (Ga denotes billion years.)

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- attempting to correlate the late Neoproterozoic Watts Needle Formation, which is exposed in the southern Shackleton Range, with similar-age sequences in Australia and western North America;
- determining paleomagnetically the position of the east antarctic craton relative to Laurentia between approximately 1.0 and 0.7 billion years ago.

Southern Coats Land nunataks

The Bertrab, Littlewood, and Moltke nunataks are exposed along the southeastern Weddell Sea coast and are herein collectively referred to as the southern Coats Land nunataks (figure 2). We mapped and sampled the Bertrab and Littlewood nunataks but were unable to visit Moltke Nunatak, which is exposed in an ice-fall. Marsh and Thomson (1984) discuss the confusion over the exact location of the Bertrab Nunataks. Using air photographs and satellite data, these authors determined the position of the largest nunatak of the group as 77˚53'S 34˚38'W. We confirmed this position using a hand-held global positioning system device, which was also used to locate and map the other nunataks of the Bertrab and Littlewood Groups.

The Bertrab Nunataks are composed of red-to-gray weathering, fine- to medium-grained, oligoclase-phyric, isotropic granophyre, which is cut by flow-banded rhyolite dikes and altered, mafic dikes (figure 2*C*) (Toubes Spinelli 1983; Marsh and Thomson 1984; Gose et al. 1997). The five small outcrops of the Littlewood Nunataks (figure 2*D*) are composed of red-weathering, densely silici-

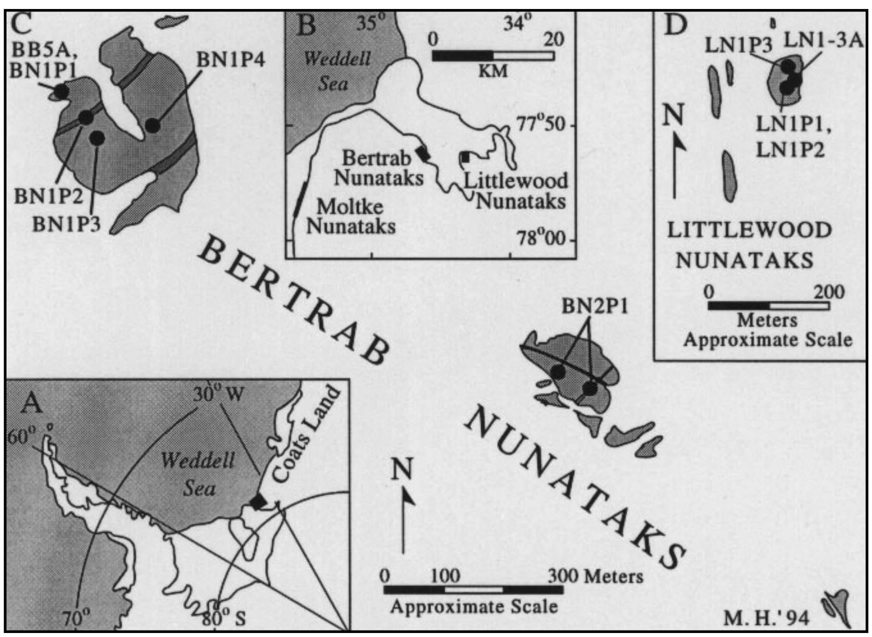

Figure 2. Maps of the Bertrab and Littlewood nunataks showing the location, geology, and sampling sites. The location of inset B is shown by the black box in inset *A*. Inset *B* shows the location of the Bertrab and Littlewood Nunataks. Medium shading in main figure (*C*) and inset *D* denotes granophyre at the Bertrab nunataks and rhyolite at the Littlewood Nunataks. Within the Bertrab Nunataks, solid, black lines are mafic dikes and northeast-trending, shaded dikes are rhyolite (after Gose et al. 1997).

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fied rhyolite (Aughenbaugh, Lounsbury, and Behrendt 1965). Storey, Pankhurst, and Johnson (1994) report a whole-rock rubidium-strontium (Rb-Sr) age of 1,076±7 million years for the Bertrab granophyre and a recalculated whole-rock Rb-Sr age of 976±35 million years for a mixture of samples from Bertrab and Littlewood nunataks. Aughenbaugh et al. (1965) report a whole-rock potassium-argon (K-Ar) age of 840±30 million years for rhyolite at the largest outcrop of the Littlewood Nunataks.

Uranium-lead (U-Pb) isotopic analyses of two fractions of zircon from the Littlewood rhyolite and two fractions of titanite from the Bertrab granophyre yield concordant U-Pb ages of 1,112±4 million years and 1,106±3 million years, respectively (Gose et al. 1997). The ages represent a crystallization age for the rhyolite and a cooling age for the granophyre. These ages support earlier suggestions of a cogenetic origin for the granophyre and rhyolite and indicate cooling of the granophyre below the magnetite Curie Point (580˚C) by approximately 1.1 billion years ago.

Eighty-four oriented samples were collected from six sites (four in the granophyre and two in rhyolite dikes) at the Bertrab Nunataks and three sites in the rhyolite at the Littlewood Nunataks (figures 2*C* and *D*). Rock magnetic and petrologic studies indicate that magnetite is the dominant carrier of magnetic remanence in the Bertrab granophyre and hematite is the carrier for the Littlewood rhyolite. Site means of the Bertrab and Littlewood samples are indistinguishable and yield a mean pole position of 23.9˚S 258.5˚E with an error of a_{95}=4.00 (Gose et al. 1997). The remanent magnetization is interpreted as a primary thermal remanent magnetization. This interpretation is supported by a lack of evidence for later thermal resetting (Aughenbaugh et al. 1965; Marsh and Thomson 1984; Gose et al. 1997), as well as a broad similarity of the Coats Land pole position with paleopoles obtained from approximately 1.0-billion-year-old rocks in Queen Maud Land (Hodgkinson 1989; Peters 1989) (figure 3) and dissimilarity to poles obtained from younger rocks in Antarctica (cf. DiVenere, Kent, and Dalziel 1995; Grunow 1995).

After rotation of the east antarctic craton about an Euler pole consistent with the SWEAT reconstruction, our new Coats Land pole falls directly on the Laurentian apparent polar wander path (APWP), lending support to the Rodinian reconstruction of Dalziel (1991) (figure 3). Our approximately 1,100-million-year-old Coats Land pole, however, overlaps poles that define the 1,000-million-year-old segment of the Laurentian APWP. Uncertainties in the age of magnetization acquisition for both the poles of the Laurentian APWP and the Coats Land pole may account for this discrepancy.

Shackleton Range

THE Shackleton Range is composed of Paleo- to Mesoproterozoic basement gneisses and granitoids overlain by upper Neoproterozoic and lower Paleozoic supracrustal rocks (Marsh 1983; Pankhurst, Marsh, and Clarkson 1983). Concurrent studies of the basement and supracrustal rocks are underway with the aim of comparing the tectonic history of the range with equivalent age rocks in the southwestern United States. Our initial efforts have focused on isotopic and structural studies of basement rocks and a paleomagnetic study of the over-

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lying Neoproterozoic clastic and carbonate rocks of the Watts Needle Formation of the Read Mountains in the southern Shackleton Range (figure 1).

In the central Read Mountains, the basement comprises middle amphibolite to granulite grade gneisses, amphibolites, and migmatites intruded by variably foliated to unfoliated granitoids (Read Group; Olesch et al. in press). Foliated but nonmylonitic migmatites and relict granulites occur north of an east-west striking, south-dipping zone of intense mylonitization, the Read Mountain Mylonite Zone (RMMZ) (Helper, Grimes, and Dalziel 1995), that transects the central part of the range. Grain size reduction textures in quartz and feldspar within mylonites of a variety of lithologies are consistent with shearing at amphibolite facies conditions. Subparallel zones of phyllonite and lower temperature mylonite within the southern portion of the RMMZ indicate renewed or continued motion at greenschist facies conditions. Both fabrics are cut by subhorizontal to moderately north-dipping, brittle shears and faults. Maximum ages of mylonitization and dynamic metamorphism are constrained by new U-Pb zircon ages of approximately 1,790 million years and approximately 1,785 million years (Helper unpublished data) for a slightly discordant, dioritic layer of mylonitic orthogneiss and a concordant deformed tonalite dike, respectively. These ages are interpreted as crystallization ages of the igneous precursors. The tonalite dike is subparallel to the mylonitic foliation and is boudinaged but not internally foliated, possibly indicating late-kinematic emplacement. Further U-Pb dating of cross-cutting dikes and granitoids, as well as high-grade

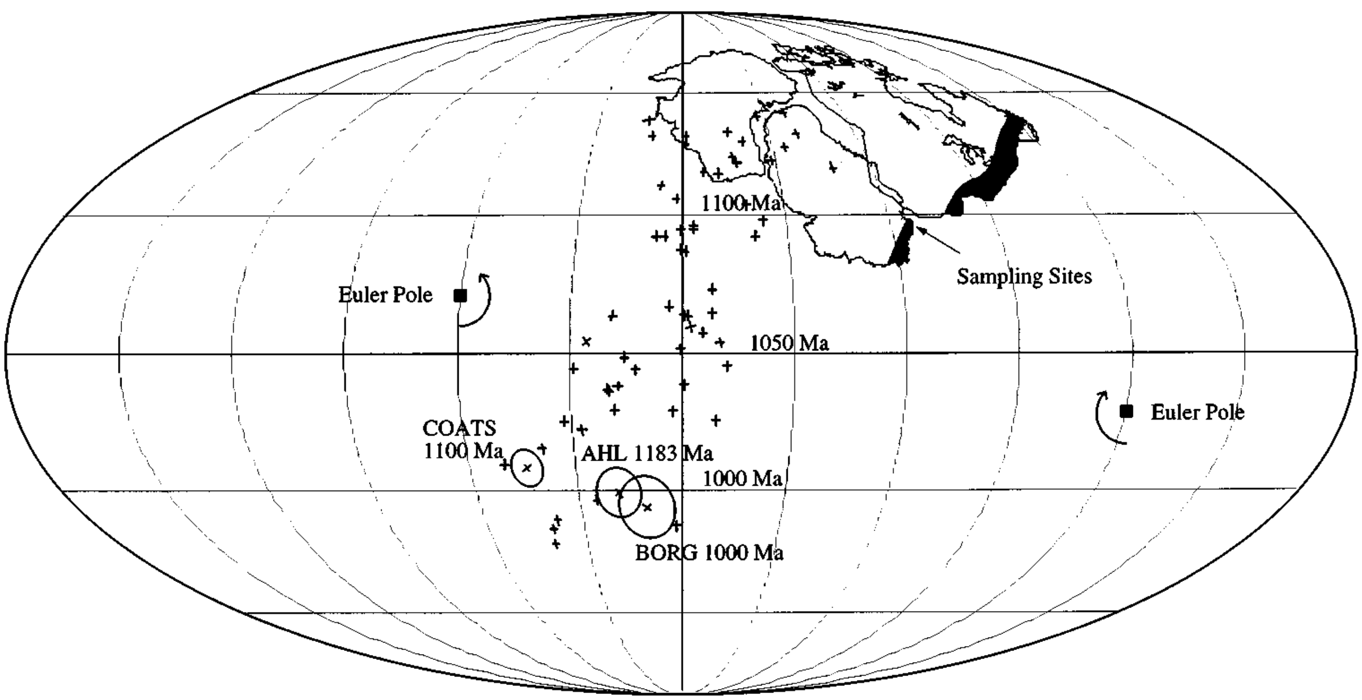

Figure 3. Precambrian virtual geomagnetic pole positions (VGPs) from Antarctica with their 95 percent circles of confidence and ages shown after rotation of the antarctic poles around an Euler pole consistent with the SWEAT reconstruction. Abbreviations: COATS, southern Coats Land (Gose et al. 1997); BORG, Borgmassivet (Hodgkinson 1989); AHL, Ahlmannryggen (Peters 1989). Crosses indicate North American paleopoles which define the Laurentian APWP with generalized ages shown for the path. North America is shown in present-day coordinates with Antarctica and Australia restored to the SWEAT reconstruction at approximately 750 million years. The Grenville Province and its proposed continuation into Antarctica is indicated by dark shading (after Gose et al. in press). (Ma denotes million years.)

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orthogneisses, is presently underway to constrain the minimum age of ductile deformation and to directly date the metamorphism.

The Watts Needle Formation is composed of a lower clastic and upper carbonate unit that rests nonconformably on Mesoproterozoic granitoids (Marsh 1983). A Vendian age has been assigned on the basis of acritarchs, stromatolites, and a whole-rock Rb-Sr model age of 720 million years (Golovanov et al. 1979; Pankhurst et al. 1983; Weber 1991). A detailed study of this unit may enable us to correlate it with other well-studied Vendian units worldwide (cf. Kirschvink et al. 1991).

We collected oriented samples from both the granitic basement (31 samples) and overlying Watts Needle Formation (157 samples) at Mount Wegener and Nicol Crags. Samples were drilled at approximately 1.0-meter intervals and 10 or more cores were collected at selected stratigraphic horizons.

Paleomagnetic results from basal red siltstones and sandstones of the Watts Needle Formation at Mount Wegener yield a preliminary mean pole position at 18.5˚S 44.3˚E with an a_{95}=7.50 (Hutson, Gose, and Dalziel 1995). A quartz arenite layer that underlies the upper carbonate section at Mount Wegener yields a preliminary mean pole position at 4.3˚S 56.4˚E with an a_{95}=11.10 (Hutson et al. 1995). A well-defined component of primary remanent magnetization for these units was not reset during later tectonic events (e.g., Ross Orogeny). Evidence for this interpretation includes the following:

- both normal and reversed polarities in samples from the quartz arenite unit and
- our pole positions, which are clearly different from published Early Paleozoic pole positions for the antarctic craton (cf. Grunow 1995).

Paleopoles from the Watts Needle Formation fall close to North American paleopoles of similar age after rotation of East Antarctica into a position adjacent to western North America, as suggested by the SWEAT hypothesis. The paleomagnetic data from the Watts Needle Formation support the juxtaposition of the Laurentian and east antarctic cratons at approximately 750 million years ago.

Paleomagnetic studies of basement rocks of the Read Mountains and the lower Paleozoic Blaiklock Glacier Group are underway. Initial results from a conglomerate test in the Blaiklock Glacier Group suggest that a primary magnetization component may be recovered from these clastic rocks.

This research is supported by National Science Foundation grant OPP 91-17996. We thank J. Connelly and Kathy Manser for assistance and technical support with U-Pb isotopic work.

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Laboratory observations of ice-floe processes made during long-term drift and collision experiments

Susan Frankenstein and Hayley Shen, Department of Civil and Environmental Engineering, Clarkson University, Potsdam, New York 13699-5710

Experiments at a laboratory in New Hampshire are helping scientists understand the annual freezing of the southern oceans and the dynamics of floes at the ice edge.

THIS article describes visual observations made during long-term multifloe drift experiments which were carried out in the refrigerated wave tank at the U.S. Army Cold Regions Research and Engineering Laboratory. The tank's length, width, and height are 36.58 meters (m), 1.22 m, and 0.61 m, respectively. A paddle spanning the width of the tank was at the far upstream end, and a gravel beach with a 1:10 slope was at the downstream end. The purpose of these tests was to determine the drift velocity and collision frequency of individual ice floes and how these factors influenced the formation of a solid ice cover. Three different wave conditions were tested, each chosen to minimize the wave reflection from the beach. The resulting wave periods ranged from 1.71 to 2.73 seconds. The air temperature during these tests was –12˚C to –5˚C.

The ice floes used for these experiments were cut from a seeded ice sheet, grown under still-water conditions. The ice sheet was composed of randomly oriented, nearly spherical crystals whose average diameter was 1.1 millimeter (mm). The average thickness of the ice sheet was 1.26 centimeters (cm). These parameters were chosen to mimic newly formed pancake ice floes. Once the ice sheet was stiff enough to handle, individual floes with a width of 20 cm and a length spanning the width of the tank were cut. Seven long-term drift experiments were performed. The motion of the floes was recorded using two time-lapse videocameras. The tests lasted 10–12 hours. The number of floes cut for each test varied from 23 to 50. The average number of floes per wavelength ranged from 16 to 28. The water surface conditions in front of and behind the floes were also varied. For the first two tests, there was open water in front of and behind the cut floes. For the next test, there were random floes in front of and behind the cut floes. For the final four tests, there were random floes in front of and open water behind the cut floes. The test conditions are summarized in the table.

To begin each test, the wave paddle was started, and the wave field was allowed to set-up. The floes were then held parallel to the wave front and as steady as possible to achieve an initial velocity of 0. After being released, the floes tended to twist slightly so that they were at an angle to the wave. The floes were not all oriented the same though. A floe's position relative to the wave was influenced by its neighbors unless there was open water between them. Thus, floe orientation tended to occur in groups. Occasionally, some floes were observed to rotate 90˚. These floes did not follow the wave surface because they were too rigid to bend.

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Some floes pivoted about their center. Most, though, began to oscillate back and forth. Thus, neighboring floes would come together and move apart. This caused water to be pumped onto the floes' surfaces resulting in the ice's surface becoming softer. This phenomenon was also observed in the field by Henderson (1962). If these floes were left undisturbed, this softer surface refroze, causing the floes to thicken.

Test conditions

Test number	Wave period (seconds)	Water depth (m)	Number of floes	Front condition	Back condition	Average ice thickness (cm)
1	2.73	0.460	23	Open water	Open water	1.10
2	2.73	0.445	30	Open water	Open water	1.18
3	2.73	0.440	39	Random floes	Random floes	1.41
4	1.71	0.430	33	Random floes	Open water	1.17
5	1.71	0.437	47	Random floes	Open water	1.14
6	1.71	0.450	42	Random floes	Open water	1.68
7	2.16	0.435	50	Random floes	Open water	1.15

Upon release, the floes were seen to drift downstream, toward the beach. At the same time, frazil formed in the open-water areas. Because some reflection occurred, there was always an open-water area at the beach where new frazil formed before being pushed upstream. Thus, the frazil was thinnest at the beach and thickest next to the floes. The force on the floes caused by this frazil growth was stronger than the wave drift force. This resulted in the floes being slowly pushed backward toward the paddle. This backward drift was not constant. Periods of no drift were interspersed with periods of drift as high as 0.00175 meters per second. The average drift velocity was $1–2\times10^{-4}$ meters per second. The magnitude of the drift and the pattern of drift vs. no drift was not related to the initial test conditions.

Besides drifting, the floes were also seen to collide. If the floes had rough edges, the floes would stick together instead of bouncing apart after contacting one another. The measured restitution coefficient averaged 0.14 for the clean collisions. The collisions appeared to coincide with the peak of the wave. Thus, collisions would be seen progressing downstream from floe to floe much like the metal balls in a Newton's cradle. The frequency of collisions was approximately the wave frequency. Often, a floe was seen to collide with one neighbor several times then collide with its other neighbor before returning to the first neighbor.

Floes were also seen to raft onto one another. This was caused by the floe field's need to relieve the pressure build up that resulted from the wave drift force being opposed by the expanding frazil. As stated earlier, many of the floes' surfaces were softened due to water being pumped onto them. When two floes began to raft, the bottom of the upper floe would push its way onto the lower floe. This motion was oscillatory. Thus, the surface of the lower floe would be scraped off ahead of the upper floe. This would cause the lower floe to become further submerged, softening it further. This process continued until the upper floe had totally rafted over the lower floe. Multiple rafting involving three or four floes was

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often seen. Occasionally, the rafting process would result in one of the floes breaking. The crack occurred perpendicular to the point of contact and seemed to be a fatigue problem.

It was also seen initially that some floes were not colliding and had open water surrounding them. In these cases, the frazil that formed in the open water adhered to the floe. Over time, this new growth hardened and thickened. Frazil that formed in the open-water area between the floes and the beach was seen to be pushed under the floes, adhering to the floes' bottoms. Along the width of a floe, this adhesion of frazil crystals was thinnest at the edges and thickest in the middle, creating a parabolic shape. Up to 6 cm of edge and bottom growth as a result of frazil adhesion was observed in a period of 2–3 hours. These same phenomena were observed in the Weddell Sea (Wadhams, Lange, and Ackley 1987; Wadhams and Holt 1991).

As has been mentioned previously, frazil formed in the open-water area between the beach and the floes. The floes essentially formed a solid barrier. Frazil could move beyond this only if it got swept underneath the floes, as was discussed in the previous paragraph. Otherwise, the frazil collected against the flow farthest downstream. As new frazil was being added at the beach, the older frazil abutting the floes became denser. The progressive wave action caused the frazil slurry to coalesce into small clumps or pancakes. These pancakes gradually grew in size and became stiffer. At this point, collisions between neighboring pancakes resulted in the formation of raised edges around the perimeter of the pancake due to the pumping of frazil crystals and water onto its surface. These raised edges formed only if there was some stiffness to the floe. Stiffer floes were observed to have higher edges. These pancakes were observed to freeze together and to raft, creating a thicker, larger, more solid ice cover. This ice cover was thinnest and softest at the beach where the wave action was greatest. These results suggest that the fact that the floes created a boundary beyond which the frazil could not move was important to the formation of the pancakes. They also suggest that wave action was important to this process.

The formation of pancakes from frazil and the eventual development of an ice cover from the pancakes have been observed to be the main ice-cover formation process in the southern oceans (Wadhams et al. 1987; Lange et al. 1989; Wadhams and Holt 1991). Other phenomena seen in the field, such as the pumping of water onto a floe's surface, were also successfully reproduced in the laboratory. New insight concerning the rafting and collision processes between neighboring floes was gained through these tests. Thus, it is seen that simple laboratory experiments are important tools in increasing our understanding of the freezing of the southern oceans and floe dynamics at the ice edge.

Thanks are given to John Gagnon for his technical assistance during the experiments. A Research Experience for Undergraduates student, Chris Moore, also assisted with the laboratory work. This study was supported by National Science Foundation grant OPP 92-19165.

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Wadhams, P., and B. Holt. 1991. Waves in frazil and pancake ice and their detection in Seasat synthetic aperture radar imagery. *Journal of Geophysical Research*, 96(C5), 8835–8852.

Wadhams, P., M.A. Lange, and S.F. Ackley. 1987. The ice thickness distribution across the Atlantic sector of the antarctic ocean in midwinter. *Journal of Geophysical Research*, 92(C13), 14535–14552.

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National Science Foundation 1998 appropriations include funding for South Pole Station construction

In an appropriations bill passed by both houses of Congress in mid-October 1997 and signed into law by President Clinton on 27 October, the National Science Foundation's (NSF) funding for fiscal year 1998 was increased 5 percent over that of the previous year. The act provides a total appropriations package of $3.429 billion, $159 million more than the fiscal year 1997 amount and $62 million more than NSF had requested for fiscal year 1998.

The act provides $70 million—over half of the $128 million required for the 8-year project to modernize facilities at Amundsen–Scott South Pole Station. The new station design was altered in 1997 to incorporate recommendations made by the 11-member U.S. Antarctic Program External Panel, which visited McMurdo and South Pole Stations last year. The panel was chaired by Norman Augustine, former Chairman of the Board and CEO of Lockheed Martin Corporation. To review the panel's final report, see http://www.nsf.gov/cgi-bin/getpub?antpanel.

In the areas of research and related activities sponsored by the NSF, the fiscal year 1998 appropriations act provides $2.546 billion, which represents an increase of $114 million, nearly 5 percent and $31 million more than was requested. House and Senate conferees also agreed to provide an additional $40 million above the current $20 million level to support an expanded plant genome research program and $1 million for the U.S.–Mexico Foundation.

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Antarctic Treaty notes

CCAMLR's Working Group on Ecosystem Monitoring and Management meets in San Diego

FORTY scientists representing 16 countries attended the third meeting of the Working Group on Ecosystem Monitoring and Management (WG-EMM) at Hubbs Sea World Research Institute in San Diego, California, in late July. The WG-EMM serves as the technical, scientific gathering in support of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR).

Rennie Holt of the National Marine Fisheries Service of the National Oceanic and Atmospheric Administration (NOAA) hosted the meeting. Participants discussed

- data on catch status and trends, harvested species, dependent species, and the environment;
- harvested species, particularly krill—methods for estimating distribution and abundance as well as analysis of recruitment and production;
- dependent species, such as birds and mammals, site protection review, methods for monitoring performance, status and trends, and performance indices;
- the environment, assessment methods, and key variables;
- ecosystem analysis, by-catch of fish in krill fishery, and interactions between ecosystem components; and
- ecosystem assessment, estimates of potential yield, and precautionary catch limits.

Workshop participants hope that planned collaborations among CCAMLR nations will increase ecosystem research coverage in the Antarctic Peninsula region on both temporal and spatial scales. Contribution from the United States will include research by both the National Science Foundation and NOAA. A workshop to compare data sets collected in the Antarctic Peninsula area will be held in 1998 in the United States. The U.S. Antarctic Marine Living Resources program and the National Science Foundation will be represented at the workshop, as will Germany, the United Kingdom, Korea, and Japan. Integrating results collected by various nations in adjacent areas in a time series mode, scientists believe, will greatly enhance the present data.

Foundation awards of funds for antarctic projects, 1 June through 30 September 1997

Award numbers for all awards initiated by the Office of Polar Programs (OPP) contain the prefix "OPP." 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. EAR denotes Division of Earth Science, Directorate of Geosciences. OCE denotes Division of Ocean Sciences, Directorate of Geosciences. As with awards split between OPP programs, antarctic program funds are listed first, and the total amount is listed in parentheses.

To read the full award abstract, use the "Search database" funded search feature, and search on the award number.

Biology and medicine

Abbott, Mark R. Oregon State University, Corvallis, Oregon. Mesoscale processes and primary productivity at the polar front. OPP 95-30507. $120,000. ($240,000)

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 97-43376. $25,600.

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. $63,364.

Bender, Michael L. University of Rhode Island, Kingston, Rhode Island. Oxygen dynamics during the JGOFS (Joint Global Ocean Flux Study) southern oceans process study. OPP 95-30746. $62,367. ($124,733)

Bender, Michael L. University of Rhode Island, Kingston, Rhode Island. Oxygen dynamics during the JGOFS (Joint Global Ocean Flux Study) southern oceans process study. OPP 97-43674. $74,254.

Boster, James S. University of Connecticut, Storrs, Connecticut. Social structure, agreement, and conflict in groups in extreme and isolated environments: A cross-cultural comparison. OPP 96-10232. $14,383. ($29,383)

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. $71,882. ($143,764)

Caron, David A. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Life in Extreme Environments (LExEN): Protistan biodiversity in antarctic marine ecosystems: Molecular biological and traditional approaches. OPP 97-14299. $27,500. ($350,000)

Colwell, Rita R. American Society for Microbiology, Washington, D.C. Colloquium on Climate Variability and Human Health: An Interdisciplinary Vision, Puerto Vallarta, Mexico, June 1997. OPP 97-10332. $5,000. ($15,000)

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Cowles, Timothy J. Oregon State University, Corvallis, Oregon. Southern oceans Joint Global Ocean Flux Study (JGOFS): Mesoscale physical and biological processes at the polar front. OPP 95-30758. $175,000. ($350,000)

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 97-43247. $14,996.

Domack, Eugene W. Hamilton College, Clinton, New York. Holocene paleoenvironmental change along the Antarctic Peninsula: A test of the solar/bipolar signal. OPP 96-15053. $16,613. ($74,503)

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 oceans. OPP 95-30734. $15,416. ($123,832)

Fauchald, Kristian. Smithsonian Institution, Washington, D.C. Biological collections from polar regions. OPP 97-42939. $145,458. ($245,458)

Fritsen, Christian H. Montana State University, Bozeman, Montana. Life in Extreme Environments (LExEN): Microbial life within the extreme environment posed by permanent antarctic lake ice. OPP 97-14339. $78,179. ($488,758)

Gaffney, Patrick M. University of Delaware, Newark, Delaware. Population structure of key antarctic fish and invertebrate resource species. OPP 97-14439. $18,715.

Huntley, Mark E. Scripps Institution of Oceanography, La Jolla, California. U.S. JGOFS (Joint Global Ocean Flux Study) southern oceans process study: Zooplankton processes. OPP 96-34052. $46,875. ($200,069)

Jeffrey, Wade H. University of West Florida, Pensacola, Florida. Ultraviolet radiation-induced DNA damage in bacterioplankton in the southern oceans. OPP 94-19037. $135,834.

Karl, David M. University of Hawaii–Manoa, Honolulu, Hawaii. Cross-site study: Microbial loop dynamics and regulation of bacterial physiology in subtropical and polar marine habitats. OPP 97-42985. $1,680. ($8,530)

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. $44,192. ($88,385)

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. $9,209. ($18,418)

Marinelli, Roberta L. Skidaway Institute of Oceanography, Savannah, Georgia. Intergovernmental Personnel Act mobility assignment. OPP 97-29403. $108,604.

Neale, Patrick J. Smithsonian Institution, Washington, D.C. New approaches to measuring and understanding the effects of ultraviolet radiation on photosynthesis by antarctic phytoplankton. OPP 96-15342. $103,509.

Priscu, John C. Montana State University, Bozeman, Montana. Antarctic lake-ice microbial consortia: Origin, distribution, and growth physiology. OPP 94-19413. $173,133.

Rapley, Chris G. International Geosphere, Stockholm, Sweden. U.S. support for central scientific co-ordination and integration activities of the International Geosphere–Biosphere Programme. OPP 96-19897. $34,129. ($675,000)

Smith, Raymond C. University of California, Santa Barbara, California. Long-term ecological research on the antarctic marine ecosystem: An ice-dominated environment. OPP 97-43377. $10,000.

Stoecker, Diane K. University of Maryland Center for Estuarine Studies, Cambridge, Maryland. Ecology and physiology of sea-ice brine microalgae. OPP 97-42294. $6,906.

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Taylor, Gordon T. State University of New York, Stony Brook, New York. Life in Extreme Environments (LExEN): Biology and ecology of South Pole snow microbes. OPP 97-13990. $50,000. ($150,000)

Trivelpiece, Wayne Z. Montana State University, Bozeman, Montana. Penguin-krill-ice interactions: The impact of environmental variability on penguin demography. OPP 96-15673. $139,882.

Wharton, Robert A. University of Nevada Desert Research Institute, Reno, Nevada. McMurdo Dry Valleys: A cold desert ecosystem. OPP 92-11773. $604,383.

Wharton, Robert A. University of Nevada Desert Research Institute, Reno, Nevada. McMurdo Dry Valleys: A cold desert ecosystem. OPP 97-43053. $2,029. ($7,356)

Marine and terrestrial geology and geophysics

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 97-42597. $3,000. ($163,990)

Aronson, Richard B. Marine Environmental Science Consortium, Dauphin Island Sea Lab, Dauphin Island, Alabama. Paleoecological setting of Eocene echinoderms at Seymour Island, Antarctic Peninsula. OPP 97-42069. $11,092.

Banerjee, Subir K. University of Minnesota–Twin Cities, Minneapolis, Minnesota. Holocene paleoenvironmental change along the Antarctic Peninsula: A test of the bipolar/solar signal. OPP 96-15695. $50,894.

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 97-42289. $19,368.

Bell, Robin E. Columbia University, New York, New York. TAMARA: Transantarctic Mountains Aerogeophysical Research Activities. OPP 96-15773. $15,000.

Bell, Robin E. Columbia University, New York, New York. Contrasting architecture and dynamics of the Transantarctic Mountains. OPP 96-15704. $138,650.

Bevis, Michael G. University of Hawaii–Manoa, Honolulu, Hawaii. Scotia Arc Global Positioning System Project (SCARP). OPP 95-30383. $55,460.

Blankenship, Donald D. University of Texas, Austin, Texas. Lithospheric controls on the behavior of the west antarctic ice sheet: Aerogeophysics of the eastern Ross Sea transect zone. OPP 93-19369. $2,759. ($172,759)

Blankenship, Donald D. University of Texas, Austin, Texas. Contrasting architecture and dynamics of the Transantarctic Mountains. OPP 96-15832. $51,350.

Blankenship, Donald D. University of Texas, Austin, Texas. Support Office for Aerogeophysical Research (SOAR). OPP 97-43077. $302,058. ($987,058)

Domack, Eugene W. Hamilton College, Clinton, New York. Holocene paleoenvironmental change along the Antarctic Peninsula: A test of the bipolar/solar signal. OPP 96-15053. $57,890. ($74,503)

Domack, Eugene W. Hamilton College, Clinton, New York. Undergraduate research initiative: Antarctic marine geology and geophysics. OPP 97-42783. $10,150.

Dunbar, Robert B. Rice University, Houston, Texas. Holocene paleoenvironmental change along the Antarctic Peninsula: A test of the bipolar/solar signal. OPP 96-15668. $41,951.

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 97-43387. $49,607.

Finn, Carol. U.S. Geological Survey, Denver, Colorado. TAMARA: Transantarctic Mountains Aerogeophysical Research Activities. OPP 96-18568. $19,000.

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Fulker, David W. University Center for Atmospheric Research (UCAR), Boulder, Colorado. Unidata: 1993 to 1998. OPP 97-43420. $1,076. ($201,017)

Harvey, Ralph P. Case Western Reserve, Cleveland, Ohio. Antarctic search for meteorites. OPP 96-15276. $79,239.

Ishman, Scott. U.S. Geological Survey, Reston, Virginia. Holocene paleoenvironmental change along the Antarctic Peninsula: A test of the bipolar/solar signal. OPP 96-15669. $12,000.

Jarrard, Richard D. University of Utah, Salt Lake City, Utah. Downhole logging for the Cape Roberts Project. OPP 94-18429. $32,257.

Kamb, Barclay. California Institute of Technology, Pasadena, California. Global positioning system measurements of crustal motion in Antarctica. OPP 95-27606. $101,680.

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. $23,664.

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 97-43976. $27,000. ($27,438,427)

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. $3,279.

Leventer, Amy. Colgate University, Hamilton, New York. Holocene paleoenvironmental change along the Antarctic Peninsula: A test of the bipolar/solar signal. OPP 97-14371. $33,740.

Leventer, Amy. Colgate University, Hamilton, New York. Late quaternary history of the western and east-central Ross Sea, Antarctica: A contribution to the West Antarctic Ice Sheet (WAIS) initiative. OPP 96-15046. $26,100.

Luyendyk, Bruce P. University of California, Santa Barbara, California. Air-ground study of tectonics at the boundary between the eastern Ross embayment and western Marie Byrd Land, Antarctica: Basement geology and structure. OPP 96-15281. $10,301.

Manley, Patricia L. Middlebury College, Middlebury, Vermont. Holocene climate change in Antarctica: Test of the bipolar/solar hypothesis. OPP 96-15670. $33,791.

Marchant, David R. Boston University, Boston, Massachusetts. Tephrochronology applied to Late Cenozoic paleoclimate and geomorphic evolution of the central Transantarctic Mountains. OPP 96-14027. $48,511.

Pittenger, Richard F. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Ship operations 1997. OCE 97-43151. $24,000. ($91,950)

Pospichal, James J. Florida State University, Tallahassee, Florida. Calcareous nanofossil biostratigraphy and paleoenvironmental history of the Cape Roberts Project cores. OPP 94-22893. $1,138.

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. $19,500.

Sears, Derek W. University of Arkansas, Fayetteville, Arkansas. *In situ* oxygen isotope measurements in chondrules from meteorites. OPP 97-22882. $3,000. ($9,000)

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

Siddoway, Christine S. Colorado College, Colorado Springs, Colorado. Air-ground study of tectonics at the boundary between the eastern Ross embayment and western Marie Byrd Land, Antarctica: Basement geology and structure. OPP 96-15282. $4,825.

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Simpson, David W. Incorporated Research Institutions for Seismology (IRIS), Washington, D.C. IRIS 2000: A science facility for studying the dynamics of the solid Earth. EAR 97-43629. $12,000. ($11,531,800)

Smalley, Robert. University of Memphis, Memphis, Tennessee. Scotia Arc Global Positioning System Project (SCARP). OPP 95-27529. $39,090.

Stock, Joann M. California Institute of Technology, Pasadena, California. Early Tertiary tectonic evolution of the Pacific–Australia–Antarctic Plate circuit. OPP 94-16779. $38,122.

Taylor, Edith L. University of Kansas, Lawrence, Kansas. Support for paleobotanical collection at the University of Kansas Natural History Museum and Biodiversity Research Center. OPP 97-12340. $60,000. ($179,944)

Verosub, Kenneth L. University of California, Davis, California. Paleomagnetic and mineral magnetic characterization of drill cores from the Cape Roberts Project. OPP 95-26889. $21,800.

Wannamaker, Philip E. University of Utah, Salt Lake City, Utah. Thermal and fluid state of the lithosphere beneath South Pole region, East Antarctica, from magnetotelluric measurements. OPP 96-15254. $156,627.

Webb, Peter-Noel. Ohio State University, Columbus, Ohio. Antarctic stratigraphic drilling: Cape Roberts Project. OPP 93-17979. $36,585.

Webb, Peter-Noel. Ohio State University, Columbus, Ohio. Cretaceous–Paleogene foraminifera of the Victoria Land Basin (Cape Roberts Project). OPP 94-20475. $4,310.

Whillans, Ian M. Ohio State University, Columbus, Ohio. Global positioning system measurements of rock and ice motions in southern Victoria Land. OPP 95-27571. $48,801.

Wilson, Gary S. Ohio State University, Columbus, Ohio. Paleomagnetic and mineral magnetic characterization of drill-cores from the Cape Roberts Project (Ohio State University component). OPP 95-27343. $26,014.

Wilson, Terry J. Ohio State University, Columbus, Ohio. TAMARA: Transantarctic Mountains Aerogeophysical Research Activities. OPP 96-15639. $36,465.

Wilson, Terry J. Ohio State University, Columbus, Ohio. Stress field history, Cape Roberts, Antarctica. OPP 95-27394. $14,778.

Witmer, Richard E. U.S. Geological Survey, Reston, Virginia. Antarctic surveying and mapping program. OPP 97-43175. $226,076. ($326,076)

Ocean and climate studies

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. JGOFS (Joint Global Ocean Flux Study) southern oceans process study. OPP 95-30861. $277,332.

Bacon, Michael P. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Thorium isotopes as indicators of export flux and particle dynamics in the southern oceans: Joint Global Ocean Flux Study (JGOFS). OPP 95-30720. $132,478.

Bromwich, David H. Ohio State University, Columbus, Ohio. Research on Ocean–Atmosphere Variability and Ecosystem Response in the Ross Sea (ROAVERRS). OPP 94-20681. $73,712.

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 oceans: Joint Global Ocean Flux Study (JGOFS). OPP 96-12761. $103,146.

Dunbar, Robert B. Rice University, Houston, Texas. Research on Ocean–Atmosphere Variability and Ecosystem Response in the Ross Sea (ROAVERRS). OPP 94-19605. $71,809.

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Foster, Theodore D. University of Delaware, Newark, Delaware. Deep water formation off the eastern Wilkes Land coast of Antarctica. OPP 97-43535. $18,699.

Hall, Michael J. National Oceanic Atmospheric Administration, Washington, D.C. Support for Argos data collection and location system. OPP 97-42310. $36,739. ($455,482)

Honjo, Susumu. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Latitudinal variations of particle fluxes in the southern oceans: A bottom-tethered sediment-trap array experiment. OPP 95-30300. $149,229.

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 97-43976. $460,293. ($27,438,427)

Leventer, Amy. Colgate University, Hamilton, New York. Research on Ocean–Atmosphere Variability and Ecosystem Response in the Ross Sea (ROAVERRS). OPP 94-20682. $66,662.

Martinson, Douglas G. Columbia University, New York, New York. ANZFLUX (Antarctic Zone Flux Experiment) modeling and analysis. OPP 96-15279. $149,000.

Martinson, Douglas G. Columbia University, New York, New York. Deep Ocean Ventilation Through Antarctic Intermediate Layers (DOVETAIL). OPP 97-42673. $11,728. ($23,728)

Millero, Frank J. University of Miami, Coral Gables, Florida. The carbon dioxide system in the southern oceans. OPP 95-30384. $145,561.

Morison, James H. University of Washington, Seattle, Washington. ANZFLUX (Antarctic Zone Flux Experiment) buoy analysis. OPP 96-15154. $105,000.

Muench, Robin D. Earth and Space Research, Seattle, Washington. Deep Ocean Ventilation Through Antarctic Intermediate Layers (DOVETAIL). OPP 95-27667. $85,095.

Padman, Laurence. Oregon State University, Corvallis, Oregon. Heat, salt, and momentum fluxes through the pycnocline in the eastern Weddell Sea. OPP 96-15524. $0. ($65,227)

Roesler, Collin. University of Connecticut, Storrs, Connecticut. Solar radiation processes in the east antarctic sea-ice zone. OPP 95-27244. $69,066.

Shen, Hayley H. Clarkson University, Potsdam, New York. Wave and pancake-ice interactions. OPP 97-42793. $10,000.

Stearns, Charles R. University of Wisconsin, Madison, Wisconsin. Continuation for the antarctic automatic weather station climate program, 1995–1998. OPP 94-19128. $266,982. ($466,982)

Warren, Stephen G. University of Washington, Seattle, Washington. Solar radiation processes in the east antarctic sea-ice zone. OPP 95-27245. $63,893.

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Besson, David Z. University of Kansas, Lawrence, Kansas. RICE—Radio–Ice Cherenkov Experiment. OPP 96-17412. $20,000.

de Zafra, Robert L. State University of New York, Stony Brook, New York. Measurement of stratospheric chlorine monoxide and other trace gases over McMurdo Station in the austral spring. OPP 96-16404. $14,838. ($54,838)

de Zafra, Robert L. State University of New York, Stony Brook, New York. Trace gas measurements over the South Pole using millimeter-wave spectroscopy. OPP 97-05667. $1,026. ($21,026)

Gregory, John C. University of Alabama, Huntsville, Alabama. Antarctic long-duration balloon flight experiments for the Japanese–American cosmic-ray emulsion-chamber experiment (JACEE) collaboration. OPP 96-17446. $20,000.

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Support and services

Hall, Michael J. National Oceanic Atmospheric Administration, Washington, D.C. Support for Argos data collection and location system. OPP 97-42310. $1,934. ($455,482)

Hernandez, Gonzalo J. University of Washington, Seattle, Washington. High-latitude antarctic neutral mesospheric and thermospheric dynamics and thermodynamics. OPP 96-15157. $60,000. ($100,314)

Inan, Umran S. Stanford University, Stanford, California. Global thunderstorm activity and its effects on the radiation belts and the lower ionosphere. OPP 97-42739. $5,000.

Mende, Stephen B. University of California, Berkeley, California. Antarctic auroral imaging. OPP 96-16809. $35,000.

Meyer, Stephan S. University of Chicago, Chicago, Illinois. Precision mapping of the cosmic microwave background radiation. OPP 96-19374. $255,000.

Papen, George C. University of Illinois, Champaign, Illinois. Rayleigh and sodium lidar studies of the troposphere, stratosphere, and mesosphere at the Amundsen–Scott South Pole Station. OPP 96-16664. $130,000.

Papen, George C. University of Illinois, Champaign, Illinois. Rayleigh and sodium lidar studies of the troposphere, stratosphere, and mesosphere at the Amundsen–Scott South Pole Station. OPP 97-43289. $1. ($2,500)

Papitashvili, Vladimir O. University of Michigan, Ann Arbor, Michigan. A study of very-high-latitude geomagnetic phenomena. OPP 96-14175. $64,750.

Piccirillo, Lucio. Bartol Research Institute, Newark, Delaware. Cosmology from Dome C in Antarctica. OPP 96-16338. $8,000.

Rust, David M. Johns Hopkins University, Baltimore, Maryland. An optical investigation of the genesis of solar activity. OPP 96-15073. $40,000. ($140,000)

Sivjee, Gulamabas G. Embry-Riddle Aeronautical University, Daytona Beach, Florida. Spectroscopic and interferometric studies of middle atmosphere dynamics and particle precipitation patterns over the South Pole. OPP 96-14158. $50,402.

Wefel, John P. Louisiana State University and A&M College, Baton Rouge, Louisiana. Antarctic long-duration balloon flights for the Japanese–American cosmic-ray emulsion-chamber experiment (JACEE) collaboration. OPP 96-14912. $20,000.

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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 97-43174. $53,817. ($68,907)

Baker, Ian. Dartmouth College, Hanover, New Hampshire. Flow and fracture of ice. OPP 97-43548. $8,500.

Bender, Michael L. Princeton University, Princeton, New Jersey. Climate studies using antarctic deep ice cores and firn air samples. OPP 95-26740. $72,189.

Biscaye, Pierre E. Columbia University, New York, New York. Origins of atmospheric dust in WAISCORES (west antarctic ice sheet cores) ice. OPP 96-15239. $85,000.

Blankenship, Donald D. University of Texas, Austin, Texas. Lithospheric controls on the behavior of the west antarctic ice sheet: Aerogeophysics of the eastern Ross Sea transect zone. OPP 93-19369. $170,000. ($172,759)

Brook, Edward J. Washington State University, Pullman, Washington. Studies of trapped gases in firn and ice from antarctic deep ice cores. OPP 97-14687. $67,825.

Fitzpatrick, Joan J. U.S. Geological Survey, Reston, Virginia. Operation and maintenance of the U.S. National Ice Core Laboratory. OPP 97-41889. $94,462. ($184,462)

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Friedmann, E. Imre. Florida State University, Tallahassee, Florida. Antarctic permafrost, Cenozoic paleoenvironment, and ground-ice stability. OPP 96-14969. $64,998.

Kamb, Barclay. California Institute of Technology, Pasadena, California. Basal conditions of ice stream D and related borehole studies of antarctic ice-stream mechanics. OPP 96-15420. $217,734. ($417,734)

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. $54,358.

Mayewski, Paul A. University of New Hampshire, Durham, New Hampshire. Siple Dome deep ice-core glaciochemistry and regional survey—A contribution to the WAIS (West Antarctic Ice Sheet) initiative. OPP 97-43552. $5,000.

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. EAR 94-10695. $10,000. ($18,708)

Wilson, Gary S. Ohio State University, Columbus, Ohio. Antarctic permafrost, Cenozoic paleoenvironment, and ground-ice stability. OPP 96-15209. $40,000.

Environmental research

Anderson, Donald M. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Characterization of indigenous and introduced toxic phytoplankton in Antarctica. OPP 96-15831. $50,000.

Detrich, H. William. Northeastern University, Boston, Massachusetts. Impacts of increased solar ultraviolet-B on antarctic marine heterotrophs. OPP 96-14892. $50,000. ($75,535)

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. $121,068.

Support and services

Besson, David Z. University of Kansas, Lawrence, Kansas. Acquisition of testing and measurement equipment at the University of Kansas in conjunction with the Radio–Ice Cherenkov Experiment (RICE) neutrino astrophysics experiment at the South Pole. OPP 97-24599. $32,706. ($231,905)

Blankenship, Donald D. University of Texas, Austin, Texas. Support Office for Aerogeophysical Research (SOAR). OPP 97-43077. $300,000. ($987,058)

Blankenship, Donald D. University of Texas, Austin, Texas. Support Office for Aerogeophysical Research (SOAR). OPP 97-43077. $385,000. ($987,058)

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. OCE 97-43512. $202,447.

Cheney, Michael E. Department of Defense, Washington, D.C. Department of Defense support to antarctic mission. OPP 97-14917. $2,000,000.

Cheney, Michael E. Department of Defense, Washington, D.C. Department of Defense support to antarctic mission. OPP 97-43739. $1,165,000.

Crabtree, Lucinda. Crabtree & Company, Arlington, Virginia. Science and engineering outreach. OPP 97-43892. $9,920. ($20,000)

Detrich, H. William. Northeastern University, Boston, Massachusetts. Impacts of increased solar ultraviolet-B on antarctic marine heterotrophs. OPP 96-14892. $25,535. ($75,535)

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Fauchald, Kristian. Smithsonian Institution, Washington, D.C. Biological collections from polar regions. OPP 97-42939. $100,000. ($245,458)

Fulker, David W. University Center for Atmospheric Research (UCAR), Boulder, Colorado. Unidata: 1993 to 1998. OPP 97-43420. $5,760. ($201,017)

Givan, May Beth. Department of Health and Human Services, Washington, D.C. Industrial and environmental hygiene services. OPP 97-43728. $50,000.

Hall, Michael J. National Oceanic Atmospheric Administration, Washington, D.C. Support for Argos data collection and location system. OPP 97-42310. $42,984. ($455,482)

Hibben, Stuart G. Library of Congress, Washington, D.C. Abstracting and indexing service for *Current Antarctic Literature*. OPP 97-43741. $205,140.

Kamb, Barclay. California Institute of Technology, Pasadena, California. Basal conditions of ice stream D and related borehole studies of antarctic ice-stream mechanics. OPP 96-15420. $200,000. ($417,734)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 97-43976. $15,245,187. ($27,438,427)

Koger, Ronald G. Antarctic Support Associates, Englewood, Colorado. Logistics support of operations/research activities related to the U.S. program in Antarctica. OPP 97-41895. $20,007,000. ($24,176,624)

Kuivinen, Karl C. University of Nebraska, Lincoln, Nebraska. Logistic and engineering support by the Polar Ice Coring Office. OPP 97-42483. $750,000. ($775,000)

Nelson, Marilyn. Blue Pencil Group, Inc., Reston, Virginia. Editorial services for the *Antarctic Journal of the United States*. OPP 97-43115. $48,117.

Onuma, Tsuyoshi. Navy Facilities and Engineering Command, Arlington, Virginia. Engineering support for antarctic program. OPP 97-42260. $100,000.

Onuma, Tsuyoshi. Navy Facilities and Engineering Command, Arlington, Virginia. Engineering support for antarctic program. OPP 97-43477. $15,000. ($1,406,000)

Owens, Barbara E. Department of the Air Force, Brooks Air Force Base, San Antonio, Texas. Environmental monitoring program for McMurdo Station, Antarctica. OPP 97-27154. $195,000.

Rounds, Fred. National Aeronautics and Space Administration, Washington, D.C. Internet telecommunications support for the U.S. Antarctic Program. OPP 97-43732. $25,000.

Rummel, John D. National Aeronautics and Space Administration, Washington, D.C. National Science Foundation/National Aeronautics and Space Administration technology demonstration. OPP 97-43822. $200,000.

Scharfen, Gregory R. University of Colorado, Boulder, Colorado. U.S. Antarctic Data Coordination Center at World Data Center–A/ National Snow and Ice Data Center. OPP 96-29768. $60,310.

Shah, Raj N. Capital Systems Group, Inc., Rockville, Maryland. Proposal processing and travel support to Office of Polar Programs, National Science Foundation. OPP 97-41176. $4,669.

Shah, Raj N. Capital Systems Group, Inc., Rockville, Maryland. Proposal processing and travel support to Office of Polar Programs, National Science Foundation. OPP 97-43924. $56,875.

Smith, Charles H. Department of Defense, Washington, D.C. Logistic support of the U.S. program in Antarctica. OPP 97-42081. $13,000,000. ($13,060,367)

Smith, Charles H. Department of Defense, Washington, D.C. Logistic support of the U.S. program in Antarctica. OPP 97-43691. $4,579,674.

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Smith, Steven. International Center for Antarctic Information, Christchurch, New Zealand. Preparation of management plans for antarctic Specially Managed Areas. OPP 97-43248. $18,000.

Stearns, Charles R. University of Wisconsin, Madison, Wisconsin. Continuation for the antarctic automatic weather station climate program 1995–1998. OPP 94-19128. $200,000. ($466,982)

Walker, Alan. Department of Transportation, Washington, D.C. Icebreaker support in the U.S. Antarctic Program. OPP 97-42960. $1,853,433.

Witmer, Richard E. U.S. Geological Survey, Reston, Virginia. Antarctic surveying and mapping program. OPP 97-43175. $100,000. ($326,076)