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# The gift of good land

Sitting in Christchurch a few days ago, watching the energetic flight of sparrows and wind swirling in the eucalyptus, and looking at bright peonies and rhododendron blossoms in the gardens and blooming chestnut trees in the park, and feeling the potential for growth in rain showers sweeping through the city, it was easy to imagine the agrarian virtue evoked in the phrase "the gift of good land."

**In this issue. . .**



But the words apply—or they should apply—here as well, to this oddly out-of-time, obviously remote, autistic fastness that we call Antarctica.

I came here, as did many of you, from far away in the Northern Hemisphere; and I came here, all things considered, rather too easily. I don't trust the speed with which I got here. It takes some of the remoteness out of the place, some of its foreignness. I don't know if that's good, to lose a sense of how complex, how very different from every other place this one is.

Seismically, Antarctica is the quietest of the continents. It's the only continent that doesn't share its continental shelf with the others—it's separated from them by a moat of deep water, the southern oceans. On none of the other continents is it so apparent that the laws of physics and chemistry, not biology, predominate, that terrestrial biology here is only a kind of Precambrian twitch, with little promise.

Here is a place without soil to grow wheat or corn, without water for the cultivation of rice, with no temperature moderate enough for animal husbandry. It offers humans no source of protein unless they turn to its fringing seas. And there are, to begin with, so few people clinging to its surface that by an analogy for scale you could stick a pin in the ground in Golden Gate Park and cover the total area of human activity.

What the continent offers in abundance is a provocation to thought. And at the close of the twentieth century, no place seems quite so thought-provoking as this one. With its treaty it is symbolic of a high-minded, transcendent politics. Last fall in Madrid, it became a symbol of restraint in the international quest for mineral resources. But I am thinking here of something more sharply etched, more deeply symbolic and closer to home: the tenor of human biology.

Antarctica—where there is no war, no famine, no inflation, no polluting industry, no dictator, no bunkered ghetto—allows us to think hard, and with little distraction, upon our biology. To confront the tenuousness of it. Underneath persistent questions about the effects of ozone fluctuation or the perturbed chemistry of the atmosphere lurks a question we'd rather not hear: Is our biology promising? In an era of catastrophic loss of spe-

"Antarctica—where there is no war, no famine, no inflation, no polluting industry, no dictator, no bunkered ghetto—allows us to think hard, and with little distraction, upon our biology. To confront the tenuousness of it. . . .In an era of catastrophic loss of species, the suspicion of some is that we ourselves are not exempt." Barry Lopez, "The gift of good land."

NSF photo by Ann Hawthorne.

**Editor:** Winifred Reuning

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cies, the suspicion of some is that we ourselves are not exempt.

We've come to this marvelous strange, preternaturally quiet place, many of us, with our curiosity heightened, with a desire to see, to participate, to fathom. It's the very wonder the place prompts, however, that draws up an intimidating and fundamental question: Where are we going? It's hard enough, of course, to ask who we are. But where are we going?

No one has the answer, for the question is larger than any single woman or man. But if our courage and our compassion for each other are to mean anything, no one can hold himself or herself outside the enquiry. (Political, social, and economic approaches to this cosmological question produce such heated debate that, out of respect for the diverging views, I would seek to pin the question on a single issue and trust that it is valid—the issue of our continuing biology. Further, people are now accustomed to saying that to be in Antarctica is a privilege. My assumption here is that it is this very sense of privilege that compels us to acknowledge the importance of this difficult inquiry into the meaning of our lives.)

Among 112 scientific projects being funded by the National Science Foundation in Antarctica this season are the following: "Physiological Ecology of UV-Absorbing Compounds in Antarctic Organisms," "The Role of Global Pollutants and Localized Contamination in Determining Hydrocarbon Concentrations Along the Antarctic Peninsula," "Measurement of Chlorine Monoxide, Nitrous Oxide and High-Altitude Ozone," "Biological Impacts of Anthropogenic Disturbances to the Marine Benthos in Antarctica." If remote Antarctica, out on the very faintest edge of human activity, is an alarm going off on a still night, as some contemplating ozone data, ice-core chemistry, and hydrocarbon pollution think is the case, how are we to interpret this?

The larger question—Where are we going?—we can break down into two smaller questions: Where are we? and What are we doing? And we can try to answer each in turn.

* * *

Antarctica, where we now are, is a physical place amenable to description. It has, ignoring fractal geometry for the moment, straightforward physical dimensions—square miles of ice, miles of coastline, heights of mountains, even a given length to its single river, the Onyx in the Wright Valley, of 30 miles. The Vinson Massif in the Ellsworth Mountains rises to 16,859 feet. The east antarctic ice sheet rises 13,450 feet above sea level and, over submerged rock basins, it is 15,700 feet thick. The coldest temperature measured here, –129.3 °F at Vostok Station on 3 July 1983, is the coldest ever measured on Earth. When anemometers have held together, wind speeds of over 200 miles per hour have been recorded.

These extreme figures, however, are oddly disembodied numbers. A truer, more reliable sense of Antarctica as a physical place, a place of human experience, comes from standing in a gravity-driven torrent of air falling so fast off the polar plateau it shatters snow flakes and so dry it absorbs the residue. It comes from probing the mystery under those katabatic winds, in those hauntingly empty, dry valleys across the sound, where it has not rained for two million years.

In those valleys—the Wright, the Barwick, the Taylor—one comes upon cryptoendolithic life ("crypto" meaning hidden, "endo" inside, "lithic" rock), bacteria, fungi, and algae hidden beneath the first few crystalline layers of rock where they're protected from the wind but still receive sunlight and oxygen enough to survive, to evolve. Over there you can stand at the edge of Don Juan Pond and contemplate a body of water so saline it doesn't freeze even in winter at –80 °F. You can ponder pieces of dolerite, a coarse, black, basalt-like stone, dished, faceted, and polished by wind-driven sand into glass-smooth, startlingly modern shapes, called ventifacts. You can confront the remains of immature crabeater and Weddell seals that came up into these valleys with a terrifyingly awry sense of direction, crawled farther until they died and then were mummified by the wind. And you can stroll across frozen lakes like Vanda and Fryxell, their thick, clear-ice lenses concentrating so much solar energy that the bottom layers of some of them reach a temperature of 113 °F.

A real sense of the physical place comes from over-wintering at Amundsen-Scott South Pole Station, where you walk around on a white, concrete-hard, often windless ocean and descend into snow tunnels, down corridors lit by an eerie, beautiful blue light, to check hibernating seismographs. And where you can see farther across a flat surface than anywhere else in the world, because the planet flattens out here.

A real sense of the place comes from sojourning on the Antarctic Peninsula, where the continent's only grass, *Deschampsia antarctica*, towers a few inches over pinhead-size springtails, and where late-summer antarctic researchers get a glimpse of darkness, a taste of night.

A real sense of the place comes from surveying in the Transantarctic Mountains for 20 seasons, from scouring blue-ice fields at the foot of the Allan Hills for meteorites. It comes from monitoring the dives of Weddell seals summer after summer and probing the tissues of antarctic fish. It comes from struggling over the whale back of the Beardmore Glacier or encountering the nearly unfathomable mass of the Lambert Glacier.

My own sense of Antarctica as a living, physical place, a place unfixable in numbers, came in several experiences. In 1988, I was working with a group of glacial chemists in southern Victoria Land. A companion, Cameron Wake, and I were stationed on a ridge overlooking the surface of Newall Glacier, where, far below, two others were marking the location of flagged survey stakes with a reflector pole. Cameron and I were measuring and recording the distance and angle to the reflector with a theodolite and tripod-mounted laser. It was cold and a terrific wind was blowing. When we did not absolutely have to be at those instruments we huddled together in a small tent out of the wind. At one point Cameron said, "I think you make the big mistake here—forgetting a sleeping bag, losing your gloves—just once."

Another time I was camped on the polar plateau, about 34 kilometers from the pole. Four of us were working out of a cold camp, just Scott tents and single-burner cook stoves, in temperatures that averaged about –30°F. Working at that altitude, pushing Nansen sleds by hand over the sticky surface of the snow, I came to respect Robert Falcon Scott's accomplishment in a way I never could having only read Roland Huntford's biography of the man.

On another occasion I was hiking in the Olympus Range, west of Bull Pass. For once in my life, I gave in to the impulse to imagine that I might be the first human being to have tread this remote ground. At that moment exactly I saw a part of a camera case lying at my feet. It had fallen out of a helicopter, I later learned, some years before.

In each of these empirical ways, people develop a real sense of the antarctic landscape—or, to put it more precisely, of that part of the antarctic landscape scientists in the United States Antarctic program visit regularly.

* * *

There is another and less intimate way to think about Antarctica, and this is to regard it as a staging platform from which, as researchers, we venture into the southern oceans or upon which we mount our electronic ears and eyes to search space. In the latter case, despite its logistical and climatic problems, Antarctica has, with the development of new sensing technologies, begun to offer us an exceptional view of the space in which our planet turns—of the Earth's atmosphere, the surface of the Sun, and of cosmic microwave background radiation, a kind of thermal activity that fills the universe. Few places on Earth, in fact, seem more like a space station now than South Pole with its congeries of observatories. The sky above is comparatively free of radio noise and empty of distorting droplets of moisture. At 9,300 feet the polar observatories are significantly closer in terms of optical clarity to the objects that interest cosmologists and astrophysicists and astronomers. And situated as they are on the Earth's polar axis, the instruments at Pole conveniently point to the same place in the sky all the time. If it were more accessible, and the climate not so severe, Amundsen-Scott Station would be an ideal place for an international observatory.

But this way of thinking about Antarctica, as a monitoring complex as much as an actual place, is new. And in the excitement that has built up in recent years over Antarctica's suitability as an instrument platform, we can see a shift, subtle but powerful, in the way we construe Antarctica's geography.

In the past, Antarctic research has been largely empirical—people with rock hammers, snow corers, sediment traps, bird bands, petri dishes, and fishing lines trying to get a feeling for the place, an understanding of it. Now, more and more often, Antarctica is seen as a place from which to take the measure of the planet, or of the space in which the planet turns. Like many people, I'm vaguely uncertain about this view. It is disquieting to think about a time when people will come here to work not because it's Antarctica but in spite of that fact, when the human encounter with this landscape will have become largely electronic. It is exactly at this point, it seems to me, at the point where human culture begins to separate itself from a real, physical place, and all the subtle responsibilities that that relationship implies, that we see emerge the first strains of long-term environmental degradation.

* * *

If, then, through personal experience and through the sorts of stories, formal and informal, that are traded among friends and colleagues, we can say *where* we are, can answer that first question, how do we answer the second one: What are we doing here?

Most of us are here to work—with the National Science Foundation, with Antarctic Support Associates, or with the military. Many of us are also here to learn—as scientists, as carpenters, as radio operators, as pilots, and as program managers—about Antarctica.

The majority of people, of course, have come here to conduct or support scientific projects. If you have a simple thirst for knowledge, if you are excited about learning where you are, the range of these projects is exhilarating and intriguing—the energetics of krill in the southern oceans; characteristics of katabatic winds from Dome C down to the antarctic coast; ice dynamics at Upstream B; solar and heliospheric studies at Pole; water circulation in the Weddell Sea; the reproductive strategies of sea birds on the Antarctic Peninsula; the biogeochemistry of lakes in the dry valleys; the uplifting of the Transantarctic Mountains; the accumulation of marine sediments on the bottom of McMurdo Sound.

Whatever it is that occupies the majority of our time, whatever it is that we are specifically interested in, we are also, many of us, trying to understand the way in which Antarctica is different from what we already know. Many of us are here, too, because we imagined that the place would be physically or spiritually or emotionally uplifting. At a more deeply private level, people are also trying to fathom themselves in this antarctic context, to imagine their coordinates, how they are fixed in time and space.

These various, overlapping reasons for choosing to come here can perhaps be understood to have a common root in a sense of responsibility. Antarctica, if we lift our eyes from the paperwork and the sorting trays, the computer screens and the microscopes, is a place of such compelling presence, is so terrifyingly abiotic, that it urges us to consider the accident of our biology, and our responsibilities toward each other because of that. It urges us, as scientists, to strive for elegance, integrity, and precision, so that we end by sharing the most reliable and penetrating thought about our situation. It urges us, as individuals, to edge closer to the intimidating questions of human existence, which have to do with purpose, with dignity and truth and love and the other things we want in our lives.

* * *

A final question, prompted by the other two—Where are we? Why are we here?—is: What are we going to take home from here?

We will, of course, carry home exciting data and samples of a certain potential; and photographs and journal entries; and a knowledge of previously unheard-of things like the Royal Vanda Swim Club and the Metaphysical Pole; and a corroboration of things we had read about but couldn't visualize in, say, Richard Byrd's *Alone* or Steve Pyne's *The Ice*, or in Huntford's *Amundsen and Scott*. From all this will come conference papers and journal articles. From it will come stories we will tell our families and friends. From it will come, we trust, a sense of personal satisfaction and a more worldly sense of the world. But we will each bring back, too, I would hope, a sense of how to approach that first, disturbing question: Where are we going? And how in choosing an answer we choose a direction.

* * *

Antarctica, owned by no one, is a gift. We can make much or little of this. We can insist that this southern landscape is not intrinsically worthy, or dignified; that its value lies only it its utility; and that what mysteries abide here are all amenable to scientific investigation and finally decipherable. But to do this is to miss something, I think, to fail to receive the gift that is offered, to fail, as it were, as a guest.

Though nothing that grows here will feed us, and though we find the climate harsh, and the place difficult of access, this is good land. It reflects, like the rainforests of the Olympic Peninsula or the Orinoco or of Sumatra, the mystery that we call God. It shows us a pattern, replicated in the less-than-orderly arrangement of subatomic particles or clouds of krill, in the emergence of mountain ranges, and in the lumpiness of the universe, a pattern that we call God.

Antarctica does not have to do anything—produce ore or fresh water or even scenery—to be valuable. Like sunlight, it is a gift. When we return home, then, the only difficulty we face is doing something with this gift, finding some way to reciprocate.

As scientists we may do this by writing thoughtfully about what we've seen or done. As people who support that research, we may give back by paying attention while we are here, so that we can speak well and knowledgeably when we return home. What any of us chooses to do, finally, is a private matter. But I would like to ask you to consider several concrete ways to reciprocate for the gift of Antarctica. One is to read a really stunning, simple, and farsighted document, the Antarctic Treaty, under the provisions of which Antarctica is protected from the extremism of nationalistic behavior and is focused instead on the courtesies of international cooperation. Historically, international relations have turned on only two points—military strength and economic power. The treaty, with its supporting protocols, conventions, and agreements, effectively removes both these lines of negotiation. It insists on a third avenue, negotiation based on the idea that all nations are equally dignified.

A second way to reciprocate for the gift of Antarctica is to contact members of the Congress and encourage them to support work carried out here that strikes you as valuable and necessary.

Finally, tell those who have never visited here what it is like, even if you only say what it's like to see the Sun reflecting off the Royal Society Range, or to have read of Edward Wilson and stood up there on Observation Hill and looked out over the Ross Ice Shelf toward the Beardmore Glacier.

We value each gift we receive by passing it on. We also value it by working to understand it. No one can understand Antarctica in its entirety. The best we can do is tell each other what we've seen on, and from, this continent, to share the sense of inquiry and wonder. For as much as we are biologically dependent on the Earth to sustain us, we are dependent upon each other for sustenance.

If our antarctic experience leaves us with no other impression but this one—that we are alive in a particular place, that our existence is precious, and that to be vigilant about any threat to our well being is wise—Antarctica will have given us, as surely as the more prosaic fruits of the Earth that feed us, the means of our survival.

When each of us departs Antarctica, when we are standing out there on the ice, making our private gesture of farewell, we will be doing more than paying our respects. We will be saying thank you—not to an idea or to a policy but to a place, a real place that will never be completely known but which will fill us with wisdom if we show the first sign of intimacy in a foreign land, a willingness to listen, the desire to hear a music one has never heard before.

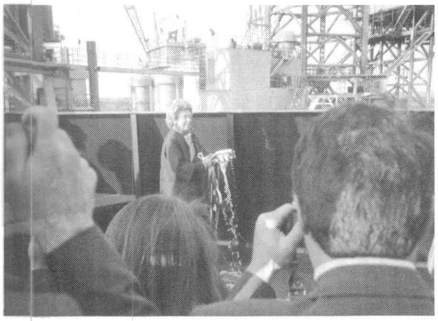
—Barry Lopez. Mr. Lopez, who is working on a book that deals in part with Antarctica, originally delivered this essay as a talk during the dedication of the Albert P. Crary Science and Engineering Center on 6 November 1991. He has visited Antarctica twice with NSF's Artists and Writers Program in 1987 and 1988. 

# NSF launches new icebreaking research ship

Officials from the National Science Foundation (NSF), senior managers of NSF's antarctic support contractor (Antarctic Support Associates), and executives from the Louisiana-based Edison Chouset Offshore (ECO) corporation gathered in Port Fourchon, Louisiana, on 13 March 1992, to dedicate the nation's first commercial icebreaking research ship. During his speech, NSF Director

***Nathaniel B. Palmer*** sets sail in the Gulf of Mexico.

Photo courtesy of Edison Chouset Offshore.



NSF photo by Al Sutherland.

Former Louisiana Congresswoman Lindy Boggs christens the United States' first commercial icebreaking research ship, ***Nathaniel B. Palmer***, during a ceremony in Port Fourchon, Louisiana.

Walter E. Massey described the 308.5-foot-long ship, christened *Nathaniel B. Palmer*, as "a floating research laboratory for NSF-supported scientists in Antarctica." Former Louisiana Congresswoman Lindy Boggs christened the ship at the dockside dedication ceremony.

The ship has more than 6,000 square feet of research space with laboratories and specialized computer and electronics facilities required to conduct antarctic research. The vessel also has state-of-the-art acoustical systems, including equipment for seismic recording, bathymetry, and precise navigation. Scientists using the ship will be able to perform multipurpose oceanographic, geological, and geophysical research. Tables 1 and 2 outline the principal characteristics of the *Nathaniel B. Palmer* and the scientific work spaces aboard the vessel.

*Nathaniel B. Palmer* will accommodate up to 37 scientists, along with a crew of 26, and will be able to stay at sea for as long as 75 days. The ship also has a helicopter landing deck and facilities for housing and maintaining two 4-passenger helicopters.

Four main diesel engines, each capable of generating up to 3,330 horsepower at 100 revolutions per minute, drive the ship, which is designed to break ice up to 3 feet thick at a speed of 3 knots. Each of its two propellers is powered by three engines, but at normal cruising speeds only one or two of the engines will be running each propeller shaft.

Besides supporting research in the southern oceans, the ship will transport scientists, their research equipment, and supplies into and out of ice-laden antarctic waters.

The *Nathaniel B. Palmer* has been under construction for the past 2 years at Larose, Louisiana. In 1990 Antarctic Support Associates, on behalf of NSF, signed a long-term charter for the construction and operation of the ship. The contract, valued at $83.8 million, covered construction, a 10-year charter, per diem charges for food and accommodations

**Table 1.**
**The R/V *Nathaniel B. Palmer*: Principal characteristics**

| | |
|---|---|
| Length overall | 308.50 feet |
| Length at waterline | 279.75 feet |
| Beam, maximum | 60.00 feet |
| Beam at design waterline | 60.00 feet |
| Draft at design waterline | 21.75 feet |
| Depth | 30.00 feet |
| Displacement | 6,500 long tons |
| Shaft horsepower | 12,720 |
| Accommodations | 37 scientists; 26 crew |
| Helicopters | Ability to carry two |
| Endurance | 75 days |
| Diesel oil tankage | 1,683 long tons |
| Classification | ABS A-2 for vessels operating in ice |

**Table 2.**
**The R/V *Nathaniel B. Palmer*: Scientific work spaces**

| | |
|---|---|
| **Laboratories** | Eight, totaling 5,440 square feet. |
| Deck bolting grid | 3/8-inch threaded boltdown fittings on a 2-foot grid pattern. |
| Unistrut sections | At 2-foot intervals on all bulkheads conforming to the deck bolting grid. |
| Fume hoods | Two laboratory-grade laminar flow class A; a 44-inch type in the Biochemical Analytical Clean Lab and a 36-inch portable, removable unit in the Wet Lab. |
| Compressed air | 15 pounds per square inch at 8-foot intervals along laboratory bench tops. |
| Sinks | Two each stainless steel in the Main Lab, Hydro Lab, and Wet Lab with two ceramic in the Biochemical Lab, and one each in the Hydro Lab and the Wet Lab. |
| **Science storerooms** | One totaling 400 square feet. One hazardous materials storeroom, 200 square feet and one cold storage room (science freezer) 120 square feet. |
| Container space | Below deck storage for four science lab/cargo vans. |
| Loading hatches | On open decks above science hold; interior access is available to each from Main Deck. |
| **Climate control chambers** | Two 8-by-8-by-10-foot chambers capable of controlling internal temperature at –1 °C ± –0.5 °C. |
| **Scientific freezer** | One 8-by-8-by-10-foot freezer capable of maintaining a temperature of –18 °C. |
| **Dark room** | Sinks and cabinets are provided; installation of autoprocessor and enlarger is planned. |
| **Diving locker** | Accessible from starboard side of the Main Deck; installation of a breathing air compressor system with storage tanks is planned. |
| **Science office** | Desk, file cabinets, bookcase, light table, chart file, and marker board are provided. |
| **Laboratory vans** | Two ISO standard 8-by-8-by-20-foot vans, configured as Hot Isotope Labs, are available on the vessel. |
| | 10 KVA, 115/208V power panel; connections for both fresh and uncontaminated seawater; two unistrut support systems with 3/8-inch threaded boltdown fittings on a 2-foot grid pattern. |
| | Full services (as stated above) are available at lab van locations in the hold, in the helicopter hangar, and on the helicopter deck. |


Photo courtesy of Edison Chouset Offshore.

During his speech at the dedication ceremony, Walter E. Massey, Director of the National Science Foundation, told the gathering that the new research ship ***Nathaniel B. Palmer*** is a "floating research laboratory for NSF-supported scientists in Antarctica."

for the duration of the charter, installation of winches and compressors, and delivery to Punta Arenas, Chile, one of the ship's home ports. The cost of operating the ship, including the contract, fuel, port charges, and other charges, will be about $11 million per year; however, the contract also gives NSF the option to buy the ship for $55 million at the end of the charter period.

During the dedication ceremony, Peter E. Wilkniss, Director of NSF's Division of Polar Programs, said that the *Nathaniel B. Palmer*'s first task is to transport U.S. scientists to and from a research station located on a mile-long ice floe in Antarctica's Weddell Sea. The scientists are part of a U.S.-Russian team gathering data on global climate and ocean currents in order to understand the effects of global warming.

The ship's namesake, an explorer who viewed Antarctica in 1820, was the first American to accomplish this feat. The son of a ship builder from Stonington, Connecticut, Nathaniel Brown Palmer (1799–1877) was a prosperous sealer, a sea captain, and a ship designer and builder. On 31 July 1820, Palmer set sail from Stonington, aboard the 47-foot sloop *Hero* with two other sealing ships. After sealing in the South Shetland Islands, Palmer took the *Hero* south to the northeast end of Orleans Strait and on 16 November 1820 was within 3 miles of the Antarctic Peninsula. In his log for that day, he noted "stood over for the Land [Antarctica] Course S by E 1/2 E."

## Third year of U.S. safety, environment, and health initiative completed: A progress update

In 1989 at the request of President Bush, Congress provided the National Science Foundation (NSF) with $8.3 million as part of a 5-year initiative to improve safety, environmental protection, and health conditions at U.S. facilities in Antarctica. This first increment was designated for the study and resolution of environmental problems that had proven intractable and for addressing safety and health concerns that required immediate action. Total funding for this comprehensive program was estimated to be $180 million.

The close of the 1991–1992 austral summer marked the end of the third year of the program. During the first 3 years, U.S. Antarctic Program (USAP) managers estimate that nearly 6 million pounds of refuse—waste materials that had accumulated over approximately 30 years and that included 1.5 million pounds of metal, asbestos, PCB's and barrels of human waste—were sorted, labeled, and containerized for removal from Antarctica to the United States where these wastes are disposed of or recycled. Other activities related to environmental protection and management have included

- the preparation by NSF of more than 55 Environmental Action Memoranda (EAMs) detailing the potential impacts of proposed projects in the Peninsula region, at Palmer, McMurdo and Amundsen-Scott South Pole stations, and at other continental sites
- the discontinuation of open burning at U.S. stations
- clean-up activities at three former U.S. facilities (two in the Peninsula region and one in northern Victoria Land)
- the implementation of recycling and environmental awareness programs at U.S. stations.

The Safety, Environment, and Health (SEH) initiative was proposed by NSF in response to two reports—a 1987 National Science Board study of NSF activities in the polar regions and a 1988 safety review of USAP. The program is designed to meet the following goals:

- **Safety:** To enhance personnel safety by achieving year-round operations in Antarctica with modern technology and at an acceptable risk level
- **Environment:** To reduce environmental impacts by cleaning up debris from past operations and by making present-day operations conform with current regulations, recent Antarctic

## Saving science on an ice floe: Critically needed fuel dropped to Weddell Sea ice-floe camp

As U.S. and Russian scientists and support personnel watched, the U.S. Air Force C-141 airplane made three low-level passes over their ice-floe camp adrift in the Weddell Sea. After the first pass to check the area, the airplane returned to drop 10 bundles, each containing 4 barrels of fuel, on the second pass and 19 bundles on the third pass. This urgently needed fuel replaced contaminated aviation fuel. Without the fuel, the success of the 5-month-long, $9-million project would have been jeopardized. U.S. participation in the project is supported by the National Science Foundation (NSF) as part of the U.S. Antarctic Program.

The C-141 airplane of the 20th Military Airborne Squadron left its base in Charleston, South Carolina, on Sunday, 29 March 1992 for Punta Arenas, Chile. On board the airplane were 115 barrels containing 5,865 gallons of new fuel, which was dropped to the isolated science camp on Wednesday 1 April by members of the 437th Airlift Wing. The camp, at the time of the airdrop, was at 70° South latitude off the east coast of the Antarctic Peninsula.

According to David Bresnahan of NSF's Division of Polar Programs, "This was not a life-threatening situation. The fuel was dropped to get helicopters back in the air and save the science. The drop was 100 percent successful, with all barrels recovered intact by the camp personnel." Although the danger was not immediate, the U.S. chief scientist at the ice-floe camp Douglas Martinson and the U.S. technical coordinator Jay Ardai pointed out in a message of thanks to the Air Force that, "In this highly active region of sea ice, there is always a chance that some of [the] rifts in the ice floe would develop through the camp itself. . . If such a situation were to develop, use of the helicopters could prove invaluable in relocating the camp to a safe region."

Using icebreakers, satellites, helicopters, and airplanes to conduct experiments on and below the ice floe, the 10 American and 10 Russian scientists, along with 12 support personnel, are studying the relatively unexplored western Weddell Sea. In this region, the delicate balance among the ocean, ice, and air critically affects the world's climate and ocean currents. Understanding the complex interactions among these phenomena is crucial to determining how changes such as global warming might affect Earth's climate.

In January scientific instruments were packed at Columbia University's Lamont-Doherty Geological Observatory in Palisades, New York, and sent to Montevideo, Uruguay, where the Russian icebreaking research ship *Akademik Federov* loaded the U.S. equipment for transport to the western Weddell Sea. The ship departed 22 January for its 1,300-mile trip. Between 28 January and 4 February, the researchers searched for a suitable ice floe, eventually selecting one that is over 1.5 miles long and about 1 mile wide, to set up their research station and an airstrip.

During March the ice-floe camp drifted northward at a rate varying from 3 to 6 miles a day. When they reach approximately 64°S and before the ice floe reaches the open ocean or begins to melt, U.S. researchers will finish their work and will be picked up by the new American icebreaking research ship *Nathaniel B. Palmer*. The Russian scientists will return to Uruguay on the board the *Akademik Federov*.

The scientists' mission is to collect the first extensive data on sea-ice-air interactions in the pack ice of the southern oceans. They will study the exchange of heat and gases between the ocean, ice, and atmosphere, movement of the sea ice, and the circulation of heat and salt in the water below the ice. Presently, scientists have only a rudimentary understanding of this system and cannot reliably predict whether global warming may cause the ice cover to disappear or to expand, or whether climate change may cause the ocean to absorb more or less heat and carbon dioxide.

The December 1992 issue of the *Antarctic Journal* will include a preliminary report on their findings.

Hazardous and recyclable wastes are loaded on to the supply ship ***Green Wave*** for removal from Antarctica.

NSF photo by the U.S. Naval Support Force Antarctica.

### Table 1. Examples of environmental actions taken at sites in the Antarctic Peninsula (including Palmer Station)

| *Category* | *Action* |
|---|---|
| Waste disposal/removal | Cessation of all open burning at Palmer Station (1989–1990 austral summer) |
| | Removal of all solid waste from Palmer Station and other sites in the Peninsula region |
| Sewage disposal (Palmer Station) | Installation of a macerator to grind all solids passing through the wastewater discharge line (1989–1990 austral summer) |
| | Installation of a submerged outfall (1989–1990 austral summer) |
| Fuel distribution system/ oil-spill prevention | Use of recycled lubrication oil to fuel Palmer Station's diesel generators |
| | Continued monitoring of the grounded Argentine ship *Bahia Paraiso* and consultation with the Argentine and Dutch governments to remove the fuel remaining in the ship |
| Clean-up of old U.S. stations | Demolition and removal of buildings and other materials from Old Palmer Station and an old British station at the site |
| | Clean-up and restoration of East Base, an historic site on Stonington Island |

Treaty Consultative Meeting recommendations that the United States has adopted, prevailing attitudes, and existing technology

- **Health:** To protect USAP participants by improving medical facilities and providing science field parties with safety experts who also have medical training.

Although before the initiative NSF had been working to improve conditions at U.S. antarctic facilities, the funding available to resolve environmental, health, and safety problems was inadequate. The increased support provided as part of the initiative has enabled NSF to speed up substantially the rate of the environmental clean-up and to begin dealing with a number of problems, including improved materials limitations and waste disposal, environmental assessments and monitoring, communications, and emergency facilities.

Looking to the future, NSF has issued a final supplemental environmental impact statement (SEIS) for the U.S. Antarctic Program. The impact statement, completed in October 1991, updates the 1980 programmatic environmental impact statement and assesses potential environmental impacts of program actions. The SEIS considers four alternatives for the continued operation of USAP. As part of the NSF-proposed alternative not only would the SEH initiative be completed but USAP operations also would be streamlined by reducing the number of support personnel and by consolidating facilities and activities, particularly at McMurdo Station. Among the activities included in the proposed alternative are completing a materials and waste management study, implementing appropriate recommendations from this study, reducing and limiting the amounts of materials taken to Antarctica, emphasizing increased efforts to remove wastes from all coastal and inland stations and sites, and completing modifications to wastewater discharging systems.

The accompanying tables highlight some of the accomplishments during the past 3 years at sites in continental Antarctica (table 1) and in the Antarctic Peninsula region (table 2). Additionally, the SEIS is available through the Office of the Environment, Division of Polar Programs, National Science Foundation, Washington, D.C. 20550.

→

Workers at McMurdo Station prepare barrels of waste materials removal from Antarctica. Over the last 3 years, the United States has removed 1,782 tons of nonhazardous solid waste, 178 tons of recyclable materials, 131 tons of hazardous solid waste, and 668 tons of hazardous liquid waste from its antarctic stations. The clean-up is part of the 5-year the Safety, Environment, and Health Initiative, which is designed to improve safety and health conditions at U.S. stations and to protect the environment.

**Table 2. Examples of environmental actions taken at continental sites (McMurdo and Amundsen-Scott South Pole Station and remote field sites)**

| *Category* | *Action* |
|---|---|
| Waste disposal/removal | Cessation of open burning at McMurdo Station's Fortress Rocks dump site (1991) |
| | Clean-up of asbestos-containing wastes and surface debris at the Fortress Rocks site |
| | Removal of 1,782 tons (3,564,000 pounds) of nonhazardous solid waste (e.g., construction debris and metals) |
| | Removal of 178 tons (365,000 pounds) of recyclable materials (e.g., glass, cardboard, white office paper, and plastics) |
| Sewage disposal (McMurdo Station) | Completion of a new 160-foot-long wastewater outfall that is submerged about 60 feet |
| | Installation of a domestic sewage macerator |
| Hazardous waste removal (McMurdo Station) | Removal of 131 tons (262,000 of pounds) hazardous solid waste (e.g., suspect, polychlorinated biphenyl-containing electrical transformers) |
| | Removal of 668 tons (1,336,000 pounds) of hazardous liquid waste (e.g., waste fuel and petroleum products, organic solvents, and various acids and bases) |
| Fuel distribution system/ oil-spill prevention | Replacement of old fuel transport line between McMurdo Station and Williams Field with a "dry break" fuel hose that has 16 fittings rather than 700 in the old line |
| | Replacement of rubber fuel bladders with seven 20,000-gallon steel storage tanks at Williams Field |
| | Deployment of oil containment booms when ships are docked at the McMurdo Station ice pier |
| | Development of two draft oil-spill contingency plans—one for McMurdo Station and one for other continental sites |
| Environmental awareness programs | Expansion of waste materials separation and recycling program by all station personnel |
| | Promotion of all-hands clean-ups of litter around McMurdo Station |

NSF photo by the U.S. Naval Support Force Antarctica.

# Reminiscences of the 1959 Antarctic Treaty Conference

Ladies and Gentlemen,

The continent of Antarctica lay sleeping peacefully in its southern fastnesses until 6 November 1940, when the Government of Chile formally adopted longitudes 53° and 9° West of Greenwich as constituting the limits of the sector over which it claimed sovereignty.

Since this sector covered part of the so-called Falkland Islands Dependencies, as well as part of Argentina claims to the southeast of Cape Horn, a whole series of negotiations was set in motion. These negotiations were to culminate in an agreement going by the name of the Antarctic Treaty, which was signed in Washington on 1 December 1959.

This dispute between three sovereign nations was the deep-seated cause underlying the document in question, although the more immediate cause was the announcement by the Soviet Government to the effect that, at the end of the International Geophysical Year in 1958, the bases which it had built for that purpose would continue to be permanently occupied.

Australia was disagreeably surprised by this announcement and, in Washington, the Commonwealth countries took steps to ensure that those Soviet bases, which had been specifically established in Australia's sector of the Antarctic, would in no way constitute a legal precedent for laying claim to sovereign rights.

The question arose as to the basis on which an agreement could be negotiated. The diplomats accordingly focused on the successful experience gained during the International Geophysical Year, and we came to learn from the scientific community that, if people were to survive in the southern polar regions, they had to support one another. Thus it was that the antarctic spirit, which was essential in the harsh natural conditions in that southern region, came into being.

The U.S. State Department already had some experience of political negotiations in connection with the Antarctic. In point of fact, in July 1948, the American official Caspar Green had visited Chile to suggest the adoption of a trusteeship regime for the region, as provided for in the United Nations Charter.

The Chilean Government rejected this suggestion, however, and Professor Julio Escudero, of Chile, advanced a possible concept which was subsequently to constitute the basis for the Antarctic Treaty. He stated that, regardless of the form which any future agreement might take, it should be made "without nations renouncing their individual rights." This was the concept around which the future Article IV of the Antarctic Treaty was to take shape.

* * *

Ten years later, in 1958, in the now celebrated circular of 2 May of that same year, the State Department proposed to 11 governments that a treaty be concluded, "freezing" the legal status quo in Antarctica.

Along with the seven countries—Chile, Argentina, the United Kingdom, Australia, New Zealand, France, and Norway—with clearly demarcated sectors, these obviously included the United States as the host country. In addition, there were three other countries—Belgium, the Soviet Union, and Japan—which had engaged in exploration activities. The total was rounded off to 12 with the inclusion of South Africa, on geographical grounds.

In late 1958 and early 1959, under the impetus of the United States, intensive diplomatic negotiations got under way. Furthermore, over a period of more than 1 year, from 24 June 1958 to the end of September 1959, two or three preparatory meetings a week were held in Washington and were to give rise to the drafting of an agreement.

The circular of 2 May 1958 had been preceded by a memorandum from the same government dated 3 March 1958, which broadly set out what I have called the more immediate reasons for the treaty. One of the paragraphs in that memorandum stated that the United States was concerned at the presence in Antarctica of expeditions which had been sent by the Soviet Union in connection with the International Geophysical Year. . . that it was very likely that that country's presence on the continent would be prolonged indefinitely, and that, failing any formal governmental commitments and the exercise of all due vigilance, it would not be possible to prevent the setting-up of permanent bases of a strategic nature or the use of the polar wastes for military testing purposes, such as nuclear weapon experiments and the launching of guided missiles.

Ladies and Gentlemen, how the world has changed over the past three decades! All the language used in the past now sounds more like science fiction—and yet it is symptomatic of the degree of mutual distrust which prevailed in the 1950s.

Strange as it may seem, the agreement which brought peace to the extreme southern tip of the planet was achieved at a time when the cold war was at its height, yet its beneficial effects have now progressively extended to the rest of the world.

If the name of one person had to be mentioned as being the key figure in the successful outcome of these negotiations, I would cite that of the U.S. Ambassador, Paul C. Daniels, who was the main author of the draft agreement.

* * *

The opening session of the conference of the Antarctic Treaty was chaired by the then U.S. Secretary of State, Christian Herter, who declared in his address that the efforts deployed by explorers and scientists had afforded an opportunity for formulating and conferring legal character on a number of high-minded principles that would ensure peace and cooperation in a vast region of the world.

The meeting was attended by leading figures from the world of diplomacy, along with others who were to become important in due course, such as Vassily Kuznetsov, of the Soviet Union, whom I was subsequently to see on many occasions in Moscow, where he came to be Vice-Chairman of the Presidium of the Supreme Soviet. But it was also attended by Prime Minister Walter Nash, of New Zealand, and Mr. Richard G. Casey and Mr. Eric H. Louw, Ministers of Foreign Affairs of Australia and South Africa, respectively.

The 12 countries which sat together for 45 days could be said to have formed three distinct groups:

- Chile and Argentina, with their impeccable nationalist credentials, which were faced with the difficult task of reaching an agreement consistent with their declarations on antarctic sovereignty, which were not familiar to the international community;
- the other countries having made declaration of sovereignty, such as the United Kingdom, Australia, New Zealand, France, and Norway, which were prepared to countenance any honorable arrangement that would preclude what they regarded as being the worst of all possible misfortunes, namely the establishment of the Soviet Union on the frozen continent, firing its rockets all over the world from that highly suitable and strategically located launching pad; and
- the United States, the Soviet Union, South Africa, Belgium, and Japan, for which Antarctica was no more than a vacant continent where it was necessary to try out a new form of peaceful co-existence.

There was no problem in agreeing on the five preambular paragraphs of the Treaty. The second of these struck a high-sounding note when it stated that: "it is in the interest of all mankind that Antarctica shall continue for ever to be used exclusively for peaceful purposes and shall not become the scene or object of international discord."

In laying stress on the "interest of all mankind," we did not imagine that mankind was going to read the Treaty carefully and that, as time went by, it would come to remind us of that provision.

* * *

What appeared to be the easiest issue to settle—the freedom of scientific research—actually proved to be the most difficult. We thought that adapting the International Geophysical Year from the purely scientific area to the international political sphere was something that was quite acceptable to everybody, but that was not the case. Argentina, through its Ambassador Adolfo Scilingo, said that Buenos Aires did not support the freedom of scientific research on account of the danger which it could entail for its sovereignty in the Antarctic. He went on repeating that "freedom of research means freedom of occupation." Only 1 week before the conclusion of the meeting at the end of November, he reported that his government accepted "freedom of scientific research in Antarctica and cooperation for that purpose, such as had been applied during the International Geophysical Year." However, this was subject to the condition that nuclear testing be outlawed throughout the continent, which caused considerable surprise among the United States and British delegations, although it was, in fact, eventually approved.

The Antarctic Treaty, therefore, won its first battle in the midst of the cold war, in that part of the planet would henceforward be dedicated to peace, and would be demilitarized and nuclear-free, while all the Treaty members would be afforded wide-ranging inspection rights. Lastly, the dispute over Antarctic territorial claims would be held in abeyance, in a bid to ensure that all those aims could really be achieved.

* * *

France was to play a decisive part in resolving the question of the status quo. At a time when the discussions on sovereignty claims were tending to drag on for rather too long, André Gros, the eminent professor of international law and legal counsel of the Quai d'Orsay, arrived from Paris and proceeded, on 29 October, to give us a professorial lecture. He was the first person to spell out what was actually being "held in abeyance." This concerned not so much actual or purported sovereign rights as the state of "antarctic litigation" as of the date on which the Treaty entered into force, and it was forbidden to make new claims or to enlarge on existing ones. None of the clauses of the Antarctic Treaty could affect the signatories and likewise "no acts or activities" taking place while the Treaty was in force could be taken as grounds for "asserting, supporting, or denying" their sovereignty.

This was an ingenious solution which put everybody's mind at rest.

Article IV formed the keystone of the entire system, without which it would not have won the support of Chile or Argentina, or obviously of France, and there would have been no Treaty.

* * *

To turn to another question, it is commonly claimed that the Washington meeting shrank from tackling the problem of environmental protection. The truth of the matter is rather different. At a time when virtually nobody in the world regarded the issue as being an urgent one, the Chilean delegation spoke of the "the Government of Chile's deep interest in the conservation and protection of natural resources, especially marine resources."

The British delegation asked whether the term "natural resources" was also to include mineral resources, while Australia stated that such protection went beyond the scope of the Treaty being discussed. South Africa supported Chile, but considered that it was preferable to specify that what was involved was the conservation of fauna and flora. Eventually, the existing wording of Article IX.1.(f), reading: "Preservation and conservation of living resources in Antarctica," was adopted as a prime subject for the first consultative meetings.

This is the earliest precedent for the Protocol which was recently adopted in Madrid.

* * *

The delegation of Chile, like that of Argentina, was respected and feared. It was for this reason that when its leader, the Chilean Senator Marcial Mora, asked how long the Treaty was supposed to last, the meeting engaged in a far-reaching debate on the question, although the majority thought that it should be of indefinite duration. Senator Mora convincingly asserted that the permanent "freezing" of Chilean sovereignty would be tantamount to renouncing it. Some days later, a proposal was made to the effect that the Treaty should not be completely impervious to change and be incapable of modification, but that, on the contrary, over and above its amendment by consensus, its revision would be allowed by a majority vote after it had been in force for 30 years. This was regarded as a provision whose application would obviously not be mandatory.

Although this provision will never be used, it has undoubtedly rendered an important service to the Antarctic System through its adaptation to the Protocol on Protection of the Environment, which thereby ensured that disagreement between its members was avoided following the rejection by some of them of the Mining Convention adopted in Wellington in 1988.

* * *

There are other questions which have likewise been responsible both for the imaginative moves they have fostered and for the ensuing negotiations, which have always been constructive. These include the situation in respect of floating pack ice, the requirements for becoming a Consultative Party, and such cases as the admission of observers, jurisdiction, defense of the Treaty, and the peaceful solution of disputes.

The work went ahead with the feeling that a useful job was being performed both for the southernmost region itself and for the world at large, but we never suspected that the Antarctic Treaty would be the starting-point for the birth of a continent with a legal status of its own which would progressively detach itself from the neighboring continents and many of their traditional rules and regulations.

Antarctica was born with its own rules which can be expected to go on developing.

* * *

We have to ask ourselves whether we had the right to act as the official representatives of all mankind in the task on which we embarked. There was no doubt in our minds about this, in view of the ties binding most of the countries—seven out of twelve—as a result of sectors having been allocated to them from the beginning of the 20th century onwards, without there being any objection from the international community, and also on account of the nature of the work involved in continuing the International Geophysical Year (1957–1958), although this is now more concerned with joint administration, especially since questions of sovereignty have been shelved.

Had there been any doubt, however, Sir Ester Denning, head of the United Kingdom delegation, sounded a warning note when he said that there should be no misunderstanding regarding the motives of the 12 powers . . . and particularly of those which, although not having hitherto taken an active interest in the Antarctic, might cast doubt on the right of any group of countries even to seem to be legislating on a matter of such worldwide importance.

He added that the Treaty would afford a just and effective method of achieving the purpose of preserving Antarctica as a natural heritage for the benefit of all mankind and concluded by saying that the Treaty would call for the abnegation of the signatory countries, which should expect not so much to draw privileges from it as to take on obligations.

These words of wisdom are not widely known.

—Oscar Pinochet de la Barra, Instituto Antarctico Chile (INACH), Santiago, Chile.

Dr. Pinochet de la Barra represented Chile at the XVIth Antarctic Treaty Consultative Meeting in Bonn, Germany, in October 1992.

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# The southern rim of the Pacific Ocean:

## Preliminary geologic report of the Amundsen Sea–Bellingshausen Sea cruise of the *Polar Sea*, 12 February–21 March 1992

During the *Polar Sea* cruise along the coast of the Amundsen Sea in the latter part of the 1991–1992 austral summer, the South Pacific Rim International Tectonic Expedition (SPRITE), an international geologic field party, examined evidence of the tectonic evolution of the Pacific margin of West Antarctica in relation to the New Zealand microcontinent and to the ancient Gondwana supercontinent. SPRITE's researchers, who were jointly supported by the United States, New Zealand, and the United Kingdom, focused on the area around Pine Island Bay. During the 1990–1991 austral summer, SPRITE had examined the area along the Ruppert and Hobbs coasts of Marie Byrd Land (figure 1) using a Twin Otter aircraft of the British Antarctic Survey (BAS), fuel supplied by the U.S. Antarctic program (USAP), and field equipment furnished by the New Zealand Antarctic Research Program. For this expedition, U.S. Navy LC-130 airplanes of the VXE-6 Squadron transported the research team from McMurdo Station to the research site, then back to McMurdo. A similar *modus operandi* is planned for the final field season near the Kohler Range in 1992–1993.

The main drainage glacier of the Pacific margin of Antarctica flows into Pine Island Bay and marks the boundary between two of the four geologic terranes that make up West Antarctica and the Marie Byrd Land and Thurston Island crustal blocks (figure 1). The only rocks exposed near this critical boundary are on several groups of small islands that are inaccessible using fixed-wing aircraft. The cruise of the *Polar Sea* that started at McMurdo Station on 12 February 1992 and terminated in Valparaiso, Chile, on 21 March 1992 was planned to provide access to these islands by helicopter, enabling SPRITE researchers to observe rock types, structure, and field relations and collect material for petrologic, geochemical, and paleomagnetic study. In conjunction with this program, *Polar Sea* undertook a bathymetric survey of the Pine Island Bay area, where no soundings had been recorded previously. The vessel also supported sea ice and cartography programs, conducted by other groups of scientists, and undertook recovery and deployment of automatic weather stations. The results of these projects will be reported separately.

The cruise was highly successful from a geologic standpoint. Excellent weather conditions during the most critical period, coupled with virtual absence of sea ice from the Pine Island Bay area, enabled us to study of all the main exposures in the islands thoroughly. While we conducted these studies, *Polar Sea* conducted the bathymetric survey, obtaining results of potential geologic, as well as hydrographic, significance. Brief landings were also made at the remote Cenozoic volcanoes of Mount Siple and Peter I Island. During the first helicopter overflight of Mount Siple, SPRITE researchers examined the summit region closely for signs of the recent activity that had been inferred from remote-sensing data.

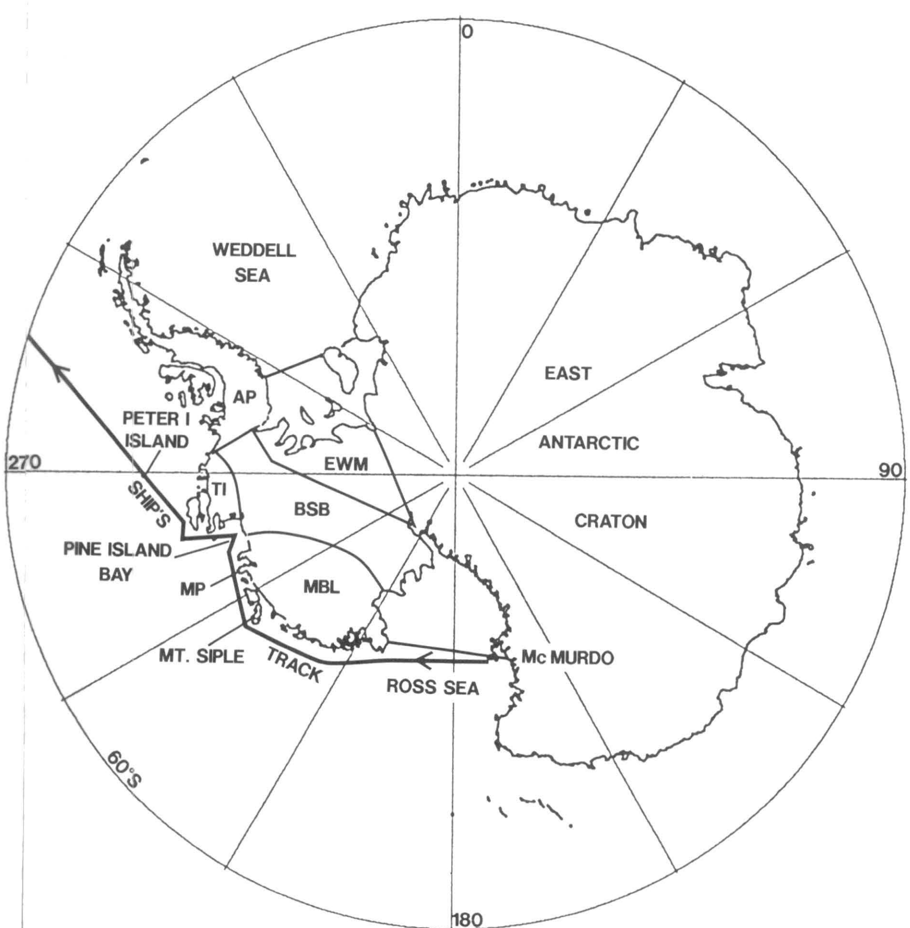



Figure 1. Track of the *Polar Sea*. (MP denotes Martin Peninsula. BSB denotes Byrd Subglocial Basin.) Crustal Blocks of West Antarctica (approximate boundaries): AP (Antarctic Peninsula), EWM (Ellsworth-Whitmore Mountains), MBL (Marie Byrd Land), TI (Thurston Island-Eights Coast).

**Pine Island Bay**

Strictly speaking, the name "Pine Island Bay" applies only to the small bay at the mouth of the Pine Island Glacier. The name is widely used, however, for the major indentation in the coastline of West Antarctica at the eastern end of the Amundsen Sea (figure 1). It is in this sense that the term is used here. The coastline of the embayment is characterized by ice cliffs. Small, but mostly inaccessible, outcrops are quite common at the base of the cliffs, but bedrock is more widely exposed and accessible in the low offshore islands. These occur exclusively along the eastern side of the embayment. A few of the islands shown on the only available map (U.S. Geological Survey Sketch Map of Thurston Island–Jones Mountains, 1:500,000, 1967)—a map constructed from air photographs—do not exist. The features on the photographs identified as islands were probably icebergs.

**Geology.** SPRITE researchers made landings at representative locations in 12 island groups, most of which consist entirely of igneous or meta-igneous rocks. The following description is subdivided on the basis of rock-type and generally follows the locally determined order of emplacement. Detailed correlations must await laboratory analysis.

*Diorite-gneiss:* Clark Island and its southern islet appear to consist mainly of intensely deformed medium-grained biotite orthogneiss, cut by irregular pegmatitic veins and enclosing mafic rafts. This gneiss may have been derived from an intermediate or mafic igneous rock such as the diorite-granodiorite found throughout the neighboring Jaynes Islands, a rock that exhibits a highly variable degree of foliation.* Similarly deformed or gneissic granitoids were found on the southernmost of the Sterrett Islands and as enclaves in younger igneous rocks on the Brownson Islands and McKinzie Islands. Comparable diorite-granodiorite also forms the exposures examined in the Waite Islands in the northern part of "Pine Island Bay."

*Granodiorite:* Partly sheared intermediate granitoids also form the oldest bedrock of most of the islands in Cranton Bay (Suchland Islands, McKinzie Islands, and Dyment Island) and of the Edwards Islands and the northern Sterrett Islands. On Dyment Island, they are involved as enclaves in a layered and contaminated intrusion breccia within a fine-grained gray, sparsely garnetiferous granitoid. The majority of the enclaves in these rocks are of microgranitoid. Many are of dioritic composition. They are either undeformed or flattened parallel to a foliation.

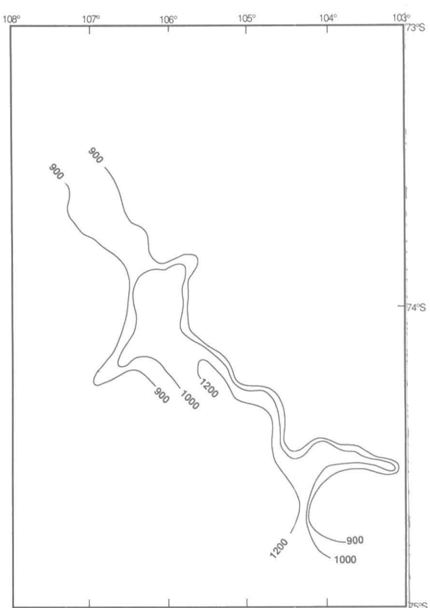
*Granite:* The Backer, Brownson, and Lindsey island groups, and a group of unnamed islands in the southeastern corner of Ferrero Bay, all display massive coarse-grained (to megacrystic) biotite-hornblende granitoids with pink feldspar phenocrysts. This rock type is locally garnet-rich. In the northern Lindsey Islands, a megacrystic granite contains patches up to 5 meters across of darker gray, more equigranular granite. These granites contain sparse mafic enclaves and sometimes have a weak mineral fabric. In the Ferrero Bay rocks, this is more strongly developed. The granites may be magmatic derivatives of the biotite-poor granodiorites seen in Cranton Bay and the Edwards Islands but are characteristically far less sheared and altered. They are frequently cut by aplites, and in some of the Brownson Islands, the latest igneous phase is a pink-weathering, medium-grained, quartz-feldspar leuco-microgranite that is homogeneous and almost enclave-free. This phase is also virtually devoid of dikes. Although this rock appears to cut the coarse-grained granite as sheets or dikes, occasionally ambiguous contacts were observed.

*Dikes:* Mafic dikes are relatively rare in the islands south of 74°S. Hornblende-diabases were seen on the Suchland, McKinzie, and western Brownson island groups. They increase in abundance toward the north. In the Edwards Islands, prominent east-west trending, basalt-to-diabase dikes dip steeply to the south. In the Lindsey Islands, where they constitute up to 30 percent of the exposed outcrop, similar dikes, up to 10 meters wide, dip to the north. Dikes of more felsic composition are also present in the Lindsey Islands, where massive (5–10 meter) gray microgranitoids, apparently of intermediate composition and also of east-west trend, have chilled margins* against the granites. Apart from these, and aplites and pegmatites obviously related to the late stages of granite emplacement, felsic dikes are rare and not always aligned with the main mafic-dike orientation. For example, a 3-meter-wide granite-porphyry dike-cutting granodiorite was observed in the McKinzie Islands, and in the southwestern Lindsey Islands, a 0.5-meter-wide felsic porphyry crosscuts both the granite and a 0.5-meter-wide east-west basalt dike.

*Other rocks:* A plagioclase-phyric rock of basaltic appearance in the southeastern Edwards Islands was interpreted as a shallow-dipping intrusive sheet. This could be genetically related to the mafic dikes in this island group, which appear petrologically similar. A small island just east of the center of the Brownson Islands is composed entirely of a coarse "appinitic" hornblende gabbro with rounded poikilitic megacrysts of hornblende up to 5 centimeters across, cut and partly net-veined by felsic material that is presumably related to the surrounding granites. Finally, an islet adjacent to eastern Clark Island is composed of a polylithic volcanic breccia with a dark-colored matrix and containing pink granite clasts.

**Bathymetry.** The eastern side of "Pine Island Bay" is underlain by a shallow shelf, mostly less than 200 meters deep. The islands of Cranton Bay and those off Canisteo Peninsula are emergent parts of this shelf. By contrast, to the west of Clark Island, there is a trough over 1,000 meters deep and 10–20 kilometers wide extending northwestward from a point approximately mid-way between the fronts of the Pine Island Bay and Thwaites glaciers. This trough was traced for more than 100 kilometers (figure 2). Although it must have been accentuated by glacial scouring, its location and trend may well reflect a significant boundary in the crustal structure of West Antarctica. Geophysical data indicate that the similar sub-ice features elsewhere in Antarctica are located along structural boundaries in the bedrock (e.g., Doake, Crabtree, and Dalziel 1973). Wade and Wilbanks (1972) noted a major difference in the geology of the Marie Byrd Land and Thurston Island areas of West Antarctica, now suspected to be crustal blocks that moved independently during the Mesozoic break-up of the Gondwana supercontinent (Grunow, Kent, and Dalziel 1991). The bathymetric deep in the eastern Amundsen Sea may represent their mutual boundary. It lies significantly west of the Udintsev Fracture Zone that marks

Figure 2. Preliminary bathymetric chart of the trough in the eastern Amundsen Sea referred to in the text.




*Foliation is the planar alignment of minerals in a rock.

*A chilled margin is the edge of an igneous body quenched by contact with cold country rock.

the flow line of the eastern limit of the New Zealand microcontinent during its Late Cretaceous separation from West Antarctica. The petrologic, geochemical, and paleomagnetic data we expect to obtain from the samples we collected will be used to test this hypothesis.

### Martin Peninsula

SPRITE researchers examined four small outcrops of rock along the west side of Martin Peninsula (figure 1) and found that they exhibit a variety of rock types. Mainly igneous (diabase, hornblendite, and a xenolithic granodiorite with a weak deformational fabric) were found, but one outcrop at Schneider Rocks (74°08'S 115°05'W) exhibited polyphase-deformed mylonitic felsic rock. Some members of the party were able to reach Wunneburger Rocks (72°42'S 113°11'W) approximately 65 kilometers inland, where they sampled uniform granodiorite. The significance of these outcrops in relation to the boundary between the Marie Byrd Land and Thurston Island crustal blocks remains to be established. The most westerly outcrop on the Walgreen Coast, Armbruster Rocks on Wright Island (73°57'S 116°49'W), was not sampled. A fly-by reconnaissance revealed that the extensive cliffs, mostly overhung by ice, contain three rock groups. The massive homogeneous jointed granitoid, a pale granitoid cut by pegmatites and a few mafic dikes, and a black closely jointed rock with igneous contacts may be comparable to those seen on the Martin Peninsula.

### Dyer Point, Thurston Island

The rocky islet at this previously unvisited locality was found to consist of homogeneous and equigranular granodiorite. There are a few enclaves of a porphyritic microgranitoid that may exhibit some flattening parallel to a mineral fabric. No aplites were seen.

### Mount Siple

Mount Siple, a prominent, but little-known, shield volcano on the coast of Marie Byrd Land at 126°34'W longitude, forms part of the Cenozoic alkali-basalt province of Marie Byrd Land. It had been visited by geologists on one previous occasion (LeMasurier and Rex 1990). Interest in this particular volcano was recently heightened by reports, based on satellite remote-sensing, of possible activity in 1988 (Smithsonian Institution 1988a), although an overflight by LC-130 from McMurdo Station revealed no evidence to support this interpretation (Smithsonian Institution 1988b). The *Polar Sea* visited Mount Siple primarily for the acquistion of geodetic data, but this afforded an opportunity for a helicopter flight over the entire structure and limited observations of exposures near the sea.

During the helicopter flight, two members of the SPRITE group (I.W.D. Dalziel and S.D. Weaver) observed no sign of recent activity. The summit is marked by a crater (?caldera) approximately 4 kilometers in diameter that is snow- and ice-filled and, therefore, has little topographic expression. The highest point, at approximately 3,394 meters (based on an estimate from the helicopter's altimeter), is an outcrop of rock on the crater rim. The rocks are draped by snow and ice and are probably thin basaltic lava flows. There are no fumerolic ice towers or other signs of current geothermal activity.

Elsewhere on the volcanic shield there are few outcrops: only two are present above 1,500 meters. Both appear to be remnants of oxidized basaltic scoria cones parasitic to the main vent. At one of these localities, on the western side of the volcano, patterned ground is well developed in the fragmental material; the stone polygons are several meters in diameter. Outcrops within 300 meters of the base of the volcano are steep-to-vertical, ice-carved exposures of layered volcanic or volcaniclastic rock. Most are inaccessible within ice cliffs.

At Maher and Lauff islands and at Lovill Bluff, there are extensive exposures of decimeter- to meter-thick bedded crystal- and lithic-rich coarse sands and breccias. These are most probably volcaniclastic base surge deposits. Lithic clasts range up to 1 meter in diameter, are matrix-supported, and are dominantly basalt or gabbro. At Lovill Bluff, cross-bedding of antidune type was observed from the air, and here the fragmental deposits are cut by irregular basaltic rubbly lava flows. The base surge deposits indicate a Surtseyan style of volcanism and represent eruption of parasitic vents located at the base of the main constructional cone at sea level. A bottom dredge from the shallow marine platform adjacent to the volcano yielded almost totally vesicular basaltic clasts.

The evidence of extensive magma-water interaction at present sea-level, the largely undissected constructional volcanic form of Mount Siple, and the presence of a summit crater all suggest that the volcano is very young. LeMasurier and Rex (1990) report a potassium-argon date of approximately 2 million years for rocks at the base of the volcano. Despite the report of a 170-kilometer "volcanic" plume from Mount Siple based on satellite images (Smithsonian Institution 1988a), we found no evidence of hot or steaming ground, fumerolic ice towers, or old ash layers. We conclude, therefore, concurring with P. Kyle's observations from an LC-130 (Smithsonian Institution 1988b), that the suggestion of an eruption at that time was incorrect.

### Peter I Island

Peter I is a volcanic island in the Bellingshausen Sea. It has been regarded as a possible active volcano (Rowley 1990). It rises from sea floor at a depth of approximately 2,000 meters to a height of 1,640 meters above sea level and is approximately 10–20 kilometers, the long dimension being parallel to a north-south trending sea floor lineament discordant to the northwest-southest trend of the Eltanin Fracture Zone. Few landings have been made on the island due to pack ice, poor weather, and heavy swell (Bastien and Craddock 1976). Poor weather and swell conditions limited our observations to those we could make from the sea along the western and eastern sides of the island and during two brief landings (total time on land only about 90 minutes) by three members of the SPRITE Group (I.W.D. Dalziel, A.M. Grunow, and S.B. Mukasa) on the western side immediately north and south of Cape Ingrid.* The high vertical cliffs along both coasts visited by the *Polar Sea* expose multiple thin subhorizontal lava flows and indicate an advanced degree of dissection. Hence, despite the freshness of the samples collected, the volcano does not appear to be in an active constructional phase. The lava varies from dark to light gray and pink and is often vesicular with occasional glomerophyric aggregates of olivine, clinopyroxene, and/or plagioclase feldspar. Geochemical data on specimens from the island have recently been published by Norwegian scientists (Prestvik et al. 1990). The tops of flows and joint surfaces are deep red because they are heavily oxidized. South of Cape Ingrid,* the sequence of flows forming the main cliffs of the island rest on the eroded top of a volcanic neck, and on the eastern side of the island, layers parallel to the southern slope appeared, from our vantage point at sea, to truncate subhorizontal layering. (Due to ice and rock overhangs on the high, vertical cliffs along the shore, there are very few places on the island where boat landings can even be attempted.)

### Notes on bird and seal observations

Because we visited all island groups in the Pine Island Bay area (in the larger groups we visited several sites), the SPRITE cruise also offered an opportunity for us to make observations on the distribution of wildlife in this rarely visited region. We found Adélie penguins on almost every landing site, in groups ranging from a few tens to several hundred. Rookeries were significant, especially on Brownson, Edwards, and Lindsey island groups. Because each of these

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**Gazetteer of the Antarctic* lists the approved name for this site as Cape Ingrid (68°46'S 90°42'W).

three groups contains about 10 individual islands, it could be suggested that they should each be classified as medium-sized rookeries (or the area in general as a single large rookery). A high percentage of the birds seen were fledglings, suggesting that larger numbers would have been present earlier in the season. We understand that this is the first report of penguin colonies along the Walgreen Coast.

Apart from the penguins, the only other form of wildlife we saw in abundance was skuas, which also had crowded breeding grounds, sometimes (e.g., in the Brownson Islands area) on a different part of an island with a penguin rookery, sometimes (e.g., Edwards Islands area) entirely occupying a separate, adjacent island. In the latter case more than 100 skuas were seen, frequently as nesting pairs and with some very young chicks.

At one site in the Lindsey Island area (74°S), we found a group of 13 elephant seals (all female) basking about 25 meters above sea level in what appeared to be a well-used wallow.

**Acknowledgments**

The SPRITE project is funded independently by National Science Foundation grants DPP 89-17127, DPP 89-16470, and DPP 90-14854 to I.W.D. Dalziel, D.V. Kent, and S.B. Mukasa, by the British Antarctic Survey, and by the New Zealand Antarctic Research Program. We are all indebted to the entire ship's company of the *Polar Sea* for outstanding support during the cruise, and especially to the aviation detachment for a safe and skillful operation.

—SPRITE Group and Captain C.G. Boyer USCG. Participants in the South Pacific Rim International Tectonic Expedition (SPRITE) cruise were J.D. Bradshaw and S.D. Weaver (University of Canterbury, Christchurch, New Zealand); R.J. Pankhurst (British Antarctic Survey, Cambridge, U.K.); I.W.D. Dalziel (University of Texas at Austin); A.M. Grunow (Ohio State and Oxford universities); and S.B. Mukasa (University of Michigan).

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# Reclaiming U.S. antarctic history: The restoration of East Base, Stonington Island

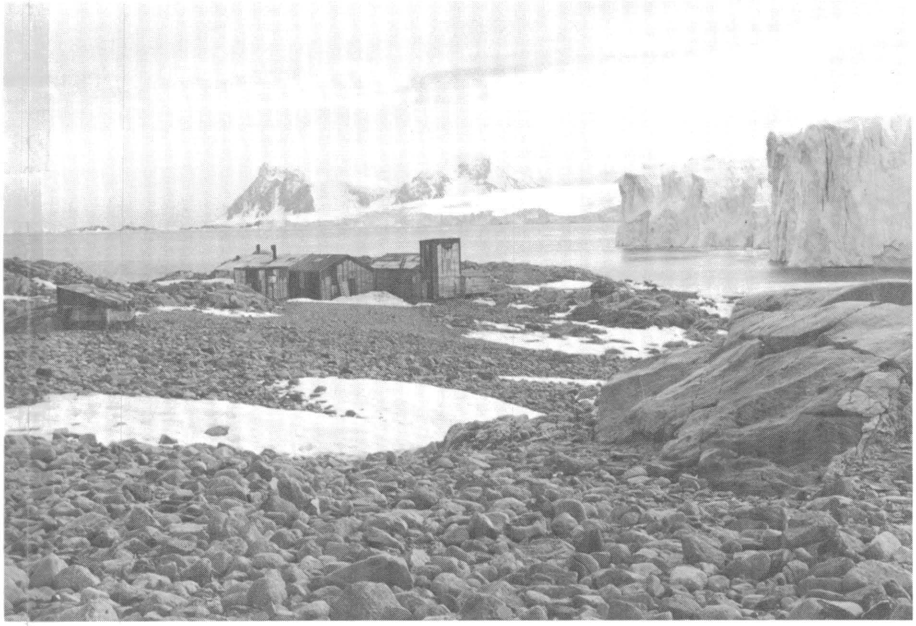
East Base is the oldest remaining U.S. research station in the Antarctic. The base, built by the U.S. Antarctic Service Expedition (USASE) under Admiral Richard E. Byrd, was one of two stations built in 1940. The other base, West Base—better known as Little America III—was built on the Ross Ice Shelf near Roosevelt Island. This station later disappeared when the ice shelf calved. Although others have visited or used East Base, the station was last used by an American expedition, the privately financed Ronne Antarctic Research Expedition, in 1947–1948.

At the 1989 Antarctic Treaty Consultative Meeting, representatives approved a recommendation that added East Base to the list of historic monuments protected by the Antarctic Treaty. The area of the historic site, as defined by this recommendation, is "approximately 1,000 meters in the north-south direction (from the beach to Northeast Glacier adjacent to Back Bay) and approximately 500 meters in the east-west directions." (Recommendation XV-12)

### U.S. Antarctic Service and Finn Ronne expeditions

USASE personnel under the direction of Richard B. Black erected the base's three main buildings and several smaller structures in 1940. The main buildings were wooden pre-fabricated structures. The largest of the buildings contained the galley at the north end and Admiral Black's quarters and the sick bay at the south end; these were connected by a corridor off of which were 10 cubicles. Other buildings constructed by USASE personnel were a science building with a meteorological tower, a machine shop, a small hut, a taxidermy shop, and a storage hut. Twenty of the 26 men in the expedition lived in the 10 cubicles off the main building's corridor; Finn Ronne (who also participated in this expedition) and one other man lived in the small hut; and the radio operator and the expedition meteorologist lived in spaces in the science building. The expedition doctor had his quarters in the main building in the sick bay.

Although the expedition's original plan called for the 26-man crew to be relieved in 1941 and for the station's continued use, the uncertainties of World War II led the U.S. government to decide that both East Base and West Base should be evacuated in 1941. After picking up personnel at the Ross Ice Shelf camp, the expedition's ships, *Bear* and *North Star*, sailed to the Peninsula region to evacuate East Base. Reaching Marguerite Bay on 24 February, the ships found the pack ice impenetrable. By 15 March ice conditions had not improved, so *North Star* returned



NSF photo by Noel Broadbent.

East Base, Stonington Island, was built by the U.S. Antarctic Service Expedition in 1940. The oldest U.S. station in Antarctica, East Base was declared an historic monument by representatives of the Antarctic Treaty Consultative Parties in 1989. During the 1990–1991 and 1991–1992 austral summers, archaeologists and historians from the National Park Service and the National Science Foundation, with the assistance of employees of NSF's antarctic support contractor, documented and restored the unused station.

to Chile for supplies in case the base could not be evacuated and the crew had to winter a second year. *Bear* traveled south to do reconnaisance work.

When *Bear* reached the Biscoe Islands, still 195 kilometers (120 miles) north of East Base, the expedition found a suitable site on low, snow-covered Watkins Island (known then as Mikkelsen Island) to build an air strip. On 22 March 1941 aboard the expedition's Condor bi-plane, USASE personnel hastily abandoned East Base and flew to Watkins Island. In two trips all personnel, data, and some specimens were evacuated; however, because of the weight limitations of the biplane, the expedition was forced to leave all other equipment, supplies, specimens, and less valuable records. A note was left on the wall of the science building, explaining that these materials belonged either to the U.S. government or to USAS expeditioners and that the U.S. Department of Interior should be notified to arrange for the return of these materials to the United States.

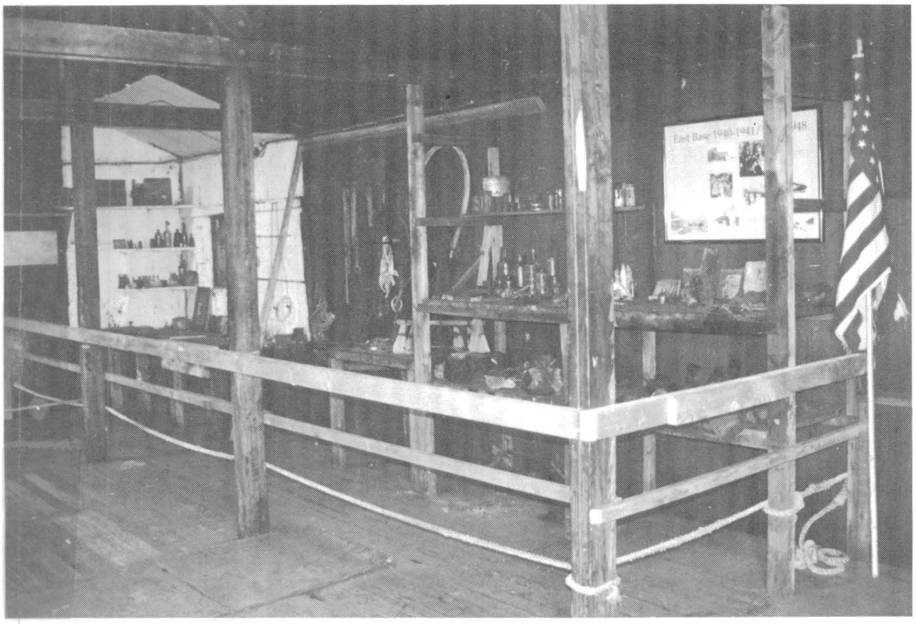
East Base was reoccupied after World War II during the 1947–1948 austral summer by the privately financed Ronne Antarctic Research Expedition (RARE) under the leadership of Finn Ronne. Among the 23 members of the RARE expedition were a Boy Scout (Arthur Owen) and the first two women ever to winter in Antarctica—J. Edith Ronne, Finn Ronne's wife, and Jennie Darlington, the recent bride of Harry Darlington III, the chief pilot.

The base had been vandalized before Ronne arrived in March 1947, and personal belongings, tools, and scientific and medical equipment had been scattered around the site. By then most of this material had already been covered by snow and ice. After the RARE expedition, British Antarctic Survey teams, who had a base nearby on Stonington Island, converted the main building into a storehouse for seal carcasses used as dog food.

Descriptions of these two expeditions and other visits to East Base before 1975 are included in two papers by Jere H. Lipps in volume XI, number 4 (December 1976), pages 211–219, and volume XI, number 4 (October 1978), pages 231–232, of the *Antarctic Journal of the United States*. In addition to Finn Ronne's published accounts of both expeditions, Kenneth J. Bertrand described in detail the plans and activities of the USASE in his book *Americans in Antarctica, 1775–1948*.

In the science building, NSF archeologist Noel Broadbent set up a display of scientific equipment and other materials used by the first U.S. expedition that occupied East Base in 1940 and 1941. This interpretive display includes photographs from the first expedition and will help visitors understand the types of science conducted at the station.

NSF photo by Noel Broadbent.



**Restoration of an historic monument**

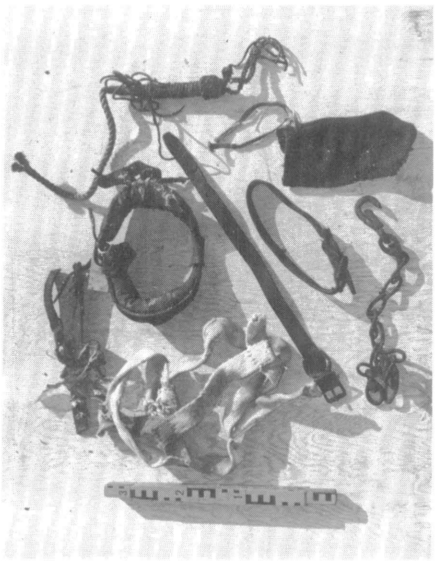
*1990–1991 restoration evaluation.* Following the 1989 declaration of the base as an historic monument, the National Science Foundation's Division of Polar Programs (DPP) sent two National Park Service (NPS) cultural resource specialists (Catherine Holder Blee and Robert L. Spude) to East Base to assess the buildings and other cultural remains at the site and to prepare a management plan.

The NPS specialists found that the site had retained surprising integrity. The three wooden, pre-fabricated buildings were still standing, as were a spare airplane engine, a U.S. Army light tank, and a tractor. They found two large food caches (mostly canned goods in wooden crates), a cache of personal survival gear probably used by Finn Ronne's expedition, and two extensive domestic garbage dumps largely untouched by either vandalism or deterioration. A number of lesser dumps and caches were also recorded.

Several items suggest that most of the material at the site dates from the U.S.


NSF photo by Noel Broadbent.

Besides repairing the buildings, the 1991–1992 restoration team put up signs like this one identifying East Base as a protected historic monument. Each sign is in English, Spanish, French, and Russian—the four official languages of the Antarctic Treaty.



NSF photo by Noel Broadbent.

Harnesses, collars, and other dog-handling equipment used by expeditioners at East Base.

A copy of the Book of Mormon found in the snow at East Base.

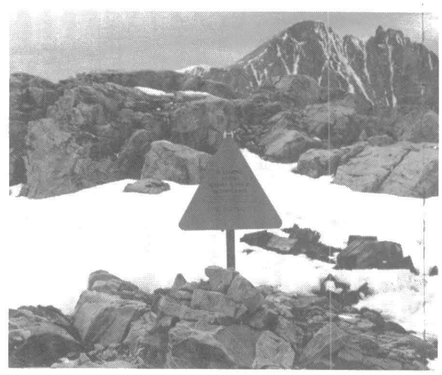
NSF photo by Noel Broadbent.

NSF photo by Noel Broadbent.

In the center of this photograph is the station's main building, that contained bunk rooms for 20 of the 26 men of the USAS expedition, a galley, and a sick bay. To the right of the main building is the science building with its meteorology tower at the end of the building. To the left is the small building in which Finn Ronne lived with a fellow expeditioner during the 1940 expedition and with his wife during his privately financed expedition.

NSF photo by Noel Broadbent.

Boots and boot liners found at the site.



NSF photo by Noel Broadbent.

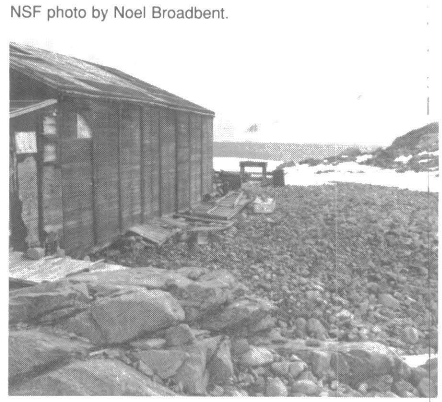
To inform visitors of the hazards of a nearby dump, the restoration team put up warning signs.

A 1939 ***Time*** magazine (still readable) found in the snow.

NSF photo by Noel Broadbent.

A view of the Antarctic Peninsula from East Base.

NSF photo by Noel Broadbent.



Antarctic Service Expedition—a duffle bag and tool chest labeled with the names of expedition members; the printed consignee addressed on the food crates; extensive remains of useable but discarded chemical, medicine, and food bottles in the dumps; and the engraved names of dogs on metal plaques, probably affixed to runs or kennels.

Organic materials were well preserved by the polar environment, and, consequently, the remnants of the seals used as dog food by the British were everywhere. In particular, the main building that had been adapted for storage of seal carcasses was littered with seal debris. Paper, cloth, and wood were also in good condition, but metal had suffered considerably from the maritime climate. Items packaged in metal canisters had deteriorated more quickly than those in more durable glass containers.

According to the NPS specialists, the large amount of debris from the two collapsed buildings and the obvious "trash" dumps created an air of neglect that would undoubtedly offend the aesthetics of environmentally conscious visitors to Antarctica. They also noted that some hazardous materials could pose a real danger to the local environment. At least 20 wooden crates containing fecal material were deteriorating on a snow bank near the camp; toxic chemicals in medicines in the trash dumps could pollute the nearby bay if allowed to migrate through the loose gravel substrate; and spilled petroleum near the original site of the generators may have contained PCB's.

Aside from documenting the existence of the pollutants, Blee and Spude reported that the cluttered appearance of the site created the impression that the base is not being kept up. They felt that this air of neglect could contribute to a loss of historic artifacts and to scavenging of the buildings themselves.

*1991–1992 site restoration.* Between 21 February and 5 March 1992, a team of eight men returned to East Base to collect artifacts systematically, to remove from the site potentially hazardous materials, and to stabilize the buildings.

Two of the team members were from the British Antarctic Survey (BAS) base Rothera, about 80 kilometers (50 miles) from East Base. At the invitation of BAS, the team lived in an old British Station on Stonington Island, Base E, which was closed in 1975 but is still maintained as a refuge.

According to archeologist Noel Broadbent, leader of the 1992 team and DPP program manager, "A fascinating assortment of items have been preserved despite the ravages of 50 years of antarctic weather." Although metal objects—cases of canned food, tools, and vehicles, including a World War I vintage tank and a small tractor—are badly rusted, books, papers, clothing, objects of wood, leather and rubber were found remarkably well preserved. Playing cards were found under the floorboards of the science lab, and an *American Digest* magazine from July 1938 was found lying out in the open, still readable. Leather dog collars with name tags—"Kelley" and "Chitma"—were found. A Woolworth size-15 shirt was found still pinned and unused. Two metal name plates of expedition members were uncovered as well—C.W. Sharbonneau, carpenter in the 1940–1941 expedition, and Bob Dodson, of the 1947–1948 expedition.

The hazardous materials, described by Blee and Spude, were excavated and removed from the site. Among these were a large assortment of medical supplies (such as pills, syringes, and drugs of various kinds), old helium-gas cylinders used for weather balloons, batteries, shotgun shells (174 of them), and asbestos from old stove plates. These hazardous substances were containerized and removed; the old medical wastes were accepted by BAS for processing. Unidentified, potentially hazardous substances were labeled and also containerized. All of these hazardous waste materials were collected and transported from the site to Palmer Station by the chartered ship *Erebus*. These will later be transfered to McMurdo Station for return to the United States. The remaining nonhazardous wastes were removed via *Erebus* from the Treaty area.

The areas around the buildings were cleaned, and gravel and rock pathways were prepared. Signs in English, French, Spanish, and Russian (the official languages of the Antarctic Treaty) were placed on each building to notify visitors of the historic status of East Base.

Inside the science lab, an interpretive display panel with photos from the first expedition was installed. A handout with more detailed information and a visitors' log were left in the building together with displays of artifacts found at the site.

"There is growing support for the preservation of historic sites in the Antarctic," Broadbent said. "We hope that there will be growing international collaboration in this endeavor."

The East Base project was incorporated into the National Science Foundation's Safety, Environment, and Health Initiative for U.S. antarctic facilities. Broadbent has suggested that the clean-up of old bases and their historic preservation can go hand in hand. "While sites like East Base are cleared of hazardous materials," he said, "a valuable record of scientific research and researchers is revealed. Protection of these historic resources is as important as the protection of the natural environment."

—Noel Broadbent, Polar Coordination and Information Section, Division of Polar Programs, National Science Foundation, and Catherine Holder Blee and Robert L. Spude, U.S. National Park Service.

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## Guatemala recognizes Treaty

In July 1991 Guatemala acceded to the Antarctic Treaty, bringing the number of acceding parties to 14. Although acceding, or nonvoting, parties accept all obligations under the Treaty, these countries do not participate in its operation. Accession to the Treaty is open to "any State which is a member of the United Nations, or any other state which may be invited to accede to the Treaty with consent of all Contracting Parties." (*Antarctic Treaty*, Article XII, paragraph 1). The other acceding parties are Austria, Bulgaria, Canada, Colombia, Czechoslovakia, Cuba, Denmark, Greece, Hungary, the Democratic People's Republic of Korea, Papua New Guinea, Romania, and Switzerland.

To achieve consultative, or voting, status, a country must demonstrate "its interest in Antarctica by conducting substantial scientific research there, such as the establishment of a scientific station or dispatch of a scientific expedition." (*Antarctic Treaty*, Article XI, paragraph 2). Consultative parties participate in deliberations, recommendations, and decisions of the Antarctic Treaty Consultative Meetings and any Special Meetings. Recommendations, which govern the operation of the Treaty, must be unanimously approved by the consultative parties but do not enter into force until the governments of all parties have ratified them.

The 26 consultative parties are the original 12 signatories to the treaty (Australia, Argentina, Belgium, Chile, France, Japan, New Zealand, Norway, the Republic of South Africa, the Soviet Union, the United Kingdom, and the United States) plus the 14 nations that have gained consultative status since the treaty was signed in 1959. They are Brazil, China, Ecuador, Finland, Germany, India, Italy, the Republic of Korea, the Netherlands, Peru, Poland, Spain, Sweden, and Uruguay.

## J.R. Bryan named curator of FSU antarctic facility

In January 1992 Jonathan R. Bryan became curator of the Florida State University Antarctic Research Facility, which is a national repository of southern ocean and antarctic continental sediments and is supported by the National Science Foundation. Dr. Bryan succeeds Dennis Cassidy, who retired in late 1991 after 28 years of service. In recognition of his dedication and years of superior service to the U.S. Antarctic Program, the National Science Foundation will honor Mr. Cassidy by presenting him with the Foundation's Meritorious Public Service Award in the 1992 fall.

The research facility and core library has received, since 1960, more than 17,000 meters of marine sediment core taken from beneath the southern oceans or continental sites. From these cores and associated collections, the facility has distributed over 200,000 samples to approximately 300 investigators representing 126 institutions in Argentina, Australia, Brazil, Canada, England, France, Germany, India, Japan, New Zealand, Scotland, the Soviet Union, Sweden, Switzerland, the United States, and Yugoslavia.

The collection includes piston, trigger and phleger cores, grab samples, and various other materials recovered during the following projects or expeditions:

- the Dry Valley Drilling Project (DVDP)
- the Ross Ice Shelf Project (RISP)
- the Eastern Taylor Valley Project
- Project CIROS (Cenozoic Investigations in the western Ross Sea)
- Operation Deep Freeze
- USNS *Eltanin*/ARA *Islas Orcadas* circumpolar survey
- Antarctic Peninsula and Ross Sea research cruises aboard the *Polar Duke*
- miscellaneous research ships working in the southern ocean

The facility is staffed by Dr. Bryan and two graduate assistants. Besides receiving, distributing, and maintaining the sediment cores, the curator and his assistants prepare descriptions of the samples for publication.

Researchers may visit the facility or request samples in writing from the curator. Samples are released after approval from NSF's Division of Polar Programs. ARF has an extensive library of antarctic and related literature and maps. A computerized data base of articles and other publications, resulting from analysis of core samples by scientists worldwide, also is maintained. These materials are available to investigators who wish to visit the facility, although the staff will respond by letter to limited literature requests.

To streamline the production of published core description volumes, the staff currently is computerizing the description process. As new volumes are available, the curator will provide copies in response to requests from ARF users. The following volumes, published previously, are still available from the core library and research facility:

- USNS *Eltanin* cruises 1-8
- USNS *Eltanin* cruises 9-15
- USNS *Eltanin* cruises 16-27
- USNS *Eltanin* cruises 32-45
- USNS *Eltanin* cruises 47-54
- USNS *Eltanin* core location data/maps and cruise 55 core descriptions
- ARA *Islas Orcadas* cruise 1176
- ARA *Islas Orcadas* cruise 1277
- ARA *Islas Orcadas* cruise 1578
- ARA *Islas Orcadas* cruise 1678
- USCGC *Glacier* 1976 and 1978 cruises
- USCGC *Glacier* Operation Deep Freeze 1981
- USCGC *Glacier* Operation Deep Freeze 1979/1980
- USCGC *Glacier* Operation Deep Freeze 1982/1983

## American scientists honored for antarctic work

Susan Solomon of the National Oceanic and Atmospheric Administration's Aeronomy Laboratory and Ian W.D. Dalziel of the Institute of Geophysics and the Department of Geological Sciences at the University of Texas at Austin both received international recognition for their achievements in science during the first part of 1992.

In March Dr. Solomon, along with five other Americans, was awarded the international Common Wealth Award for 1992 for outstanding achievement in the world communiction. The award, funded by a trust established by the will of Ralph Hayes (a former director of Coca-Cola, the New York Community Trust, and Bank of Delaware), is now in its 13th year and has bestowed more than $1 million on 85 honorees. This year's recipients will each receive $25,000.

Dr. Solomon, who was also recently elected to the National Academy of Sciences, earned her 1992 Common Wealth Award in science and invention for her work in linking manmade chlorofluorocarbons (CFCs) to the destruction of the ozone layer above Antarctica. The other four 1992 awardees are Cable News Network founder Ted Turner, novelist James A. Michener, retired Chief Justice of the U.S. Supreme Court Warren E. Burger, and playwright Arthur Miller.

For his authoritative work on the geology of South America and Antarctica, Dr. Dalziel was awarded the Murchison Medal of the United Kingdom's Geological Society, one of the oldest scientific organizations in the world. The Murchison Medal, awarded annually since 1873, was established in honor of Sir Roderick Murchison, who was a pioneer in determining the stratigraphic history of the earth. The award recognizes earth scientists who have made a significant contribution to earth science by means of a substantial body of research.

Dr. Dalziel's principal contributions have been in the study of the processes by which mountains are formed along the margin of the Pacific Ocean and in the development of the southern continents and ocean basins. His work has helped scientists to recognize that the uplift of the Andes started when the floor of a series of small ocean basins was uplifted about 100 million years ago. He also has organized and led an international team of earth scientists to study the interior of Antarctica. The efforts of this group have shown that West Antarctica actually consists of four separate microcontinents that moved relative to each other and to the main part of Antarctica that lies to the south of Africa, India, and Australia and that Antarctica did not assume its present geographic position until about 90 million years ago when New Zealand broke away from West Antarctica. Most recently, he and Eldridge Moores of the University of California at Davis put forth the controversial hypothesis that the Pacific margins of North America and Antarctica were once juxtaposed and that the Pacific Ocean Basin was formed when they drifed apart about 650 million years ago.

Dr. Dalziel will receive the Murchison Medal in June at a ceremony in London, England.

## U.S. personnel winter at three stations

The following lists researchers and employees of Antarctic Support Associates (ASA), the National Science Foundation's support contractor, who are wintering at the three U.S. year-round stations—McMurdo, Amundsen-Scott South Pole, and Palmer—during the 1992 austral winter, and U.S. Navy personnel who are wintering at McMurdo Station during 1992. The list is arranged by station with names in alphabetical order. For researchers, the title of their research project and the name of the institution to which the NSF grant was awarded are indicated; for employees of the contractor (ASA), positions at the station are included. Ranks are provided for Navy (NSFA) personnel.

**McMurdo Station**

Adamiak, Greg C., welder, ASA.
Agnew, Jay C., heavy equipment operator, ASA.
Anderson, Dennis A., plumber, ASA.
Anderson, Dennis L., electrician, ASA.
Anderson, James D., water plant mechanic, ASA.
Anderson, Mark B., ETC, NSFA.
Anderson, Timothy A., ET2, NSFA.
Aniel, Fernando D., SK1, NSFA.
Armand, Kenneth J., YN1, NSFA.
Arnsperger, Gregg P., telephone exchange technician, ASA.
Baker, Donald E., MS3, NSFA.
Banks, Michael J., DC2, NSFA.
Barrett, Yvette D., general assistant, ASA.
Beattie, Todd C., EO1, NSFA.
Beeler, Wendy, clerk typist, ASA.
Benton, Margaret M., programmer, ASA.
Berggren, Allen C., water plant technician, ASA.
Bergnes, Michael, insulator, ASA.
Berkebile, Roy A., power plant technician, ASA.
Beyer, Alfred F., carpenter, ASA.
Beyer, Jacqueline, materialsperson, ASA.
Beyer, Timothy J., electrician, ASA.
Bing, Tracey L., SH1, NSFA.
Bishop, William, power plant technician, ASA.
Blustein, David, computer technician, ASA.
Bogle, Lori, materialsperson, ASA.
Bolen, Robert, heavy equipment mechanic, ASA.
Briggs, Timothy P., senior construction coordinator, ASA.
Brown, Mark A., MS1, NSFA.
Brown, Thomas, heavy equipment mechanic, ASA.
Bruner, Richard, lineman foreman, ASA.
Brush, Richard, labor foreman, ASA.
Burkett, Eric, general assistant, ASA.
Byrne, Stephen M., waste retro materialsperson, ASA.
Campbell, Charles R., electrician, ASA.
Carr, Eric G., carpenter, ASA.
Carr, Roger, switchgear technician, ASA.
Cave, Norma I., MS2, NSFA.
Chaplin, Mary L., clerk typist, ASA.
Clayburn, Dennis D., DC3, NSFA.
Conlin, Patrick G., ABF2, NSFA.
Cooley, Erik A., janitor, ASA.
Crebbin, Cory J., Lt., officer-in-charge, NSFA.
Creel, Norman R., HMCM, NSFA.
Crenshaw, John, ironworker, ASA.
Croke, Robert, communications technician, ASA.
Crowley, Sean T., EO1, NSFA.
Cummings, Thomas L., electrician helper, ASA.
Czop, George P., power/water plant supervisor, ASA.
Davis, Shawn J., SK1, NSFA.
DeBoer, Jason C., carpenter helper, ASA.
Delmastro, David P., painter, ASA.
Desaulniers, Nicole, assistant supervisor, lab operations, ASA.
Devries, Sandra L., BU2, NSFA.
Diller, Winch E., HMC, NSFA.
Dodge, Carl, carpenter, ASA.
Dorpinghaus, Jason, materialsperson, ASA.
Drake, Robert E., sheetmetal worker, ASA.
Dunsworth, Franklin, plumber foreman, ASA.
Ebel, Michael, water plant technician, ASA.
Egeland, Harry, pm mechanic, ASA.
Egeland, Roy, heavy-equipment mechanic, ASA.
Ellis, Theodore T., ET1, NSFA.
Ely, Scheffer, boiler plant technician, ASA.
Evans, Earl T., ET2, NSFA.
Fetterolf, Lisa, inventory control specialist, ASA.
Fields, Paul, plumber, ASA.
Finn, Edward M., NSF representative McMurdo, ASA.
Finnemore, Michael H., "Satellite observation and ionospheric studies," (S-051).
Flynn, David, plumber helper, ASA.
Folger, Lora L., information systems coordinator, ASA.
Franks, Patrick, water plant technician, ASA.
Fraser, Matthew, electrician helper, ASA.
Frederickson, Katherine, trouble clerk, ASA.
Fredrickson, Delvin E., carpenter, ASA.
Gabrish, Gerald, materialsperson, ASA.
Gardner, James W., resident manager, ASA.
Gagan, George M., EA1, NSFA.
Gannon, Lisa A., ET2, NSFA.
Gehlhausen, Larry, plumber, ASA.
Gibbs, David, inventory control specialist, ASA.
Gibson, Stephen, plumber, ASA.
Gillis, Michael A., BUC, NSFA.
Goldman, Jeffrey, science technician, ASA.
Gould, Eliot, power plant technician, ASA.
Grasso, Robert L., BU2, NSFA.
Gray, Alan, power plant mechanic, ASA.
Gray, Juanita, water plant mechanic, ASA.
Greaney, John, EA2, NSFA.
Gulick, Cheryl, senior materialsperson, ASA.
Haals, Bill E., operations supervisor, ASA.
Hackett, Malachy, electrician, ASA.
Hall, Madison W., water plant technician, ASA.
Hancock, Michael, computer technician, ASA.
Harboe-Carr, Ria, secretary, ASA.
Harrison, Roy K., heavy equipment mechanic, ASA.
Hausner, Steven, insulator, ASA.
Hegtvedt, Patricia L., PN1, NSFA.
Hemphill, Mickey, insulator foreman, ASA.
Henman, Daniel, electrician, ASA.
Herrick, James J., electrician foreman, ASA.
Hicks, Danny, welder, ASA.
Hill, Kay, painter, ASA.
Hoagland, Marybeth, inventory control specialist, ASA.
Hoffman, David R., title-two inspector.
Hoffman, Dennis J., carpenter, ASA.
Howard, Scott R., DC3, NSFA.
Hume, Mark, light vehicle mechanic, ASA.
Jachymowski, Steve, utility mechanic, ASA.
Jacobson Jr., Max, carpenter helper, ASA.
Jacobson, Russell, heavy equipment operator, ASA.
Japp, Robert J., AG3, NSFA.
Jenkins, Larry, boiler mechanic, ASA.
Jirschele, Samuel, janitor, ASA.
Jones, Randy W., machinist, ASA.
Jones, Terry, incinerator operator, ASA.
Karr, Edward, incinerator operator, ASA.
Kausch, Matthew, sheetmetal helper, ASA.
Keys, Joanne, programmer/analyst, ASA.
Kiser, Carl, drywaller, ASA.
Kitchen, Kirkland K., IC1, NSFA.
Krippner, Linda, assistant supervisor, lab operations, ASA.
Krippner, Steve A., field processing technician, ASA.
Kuehn, Brad, sheetmetal foreman, ASA.
Kunze, Daniel, preventive maintenance mechanic, ASA.
Labelle, Jill, data entry clerk, ASA.
Lange, Daral F., heavy equipment operator, ASA.
Langston, Bryan, incinerator operator, ASA.
Lankford, Thomas, sheetmetal worker, ASA.
Lavigne, Sarah, RM1, NSFA.
Lee, Robin, drywaller, ASA.
Lester, James, heavy equipment mechanic, ASA.
Lewis, Martin E., light vehicle mechanic, ASA.
Lewis, Roland, SH3, NSFA.
Marchetti, Peter, shop foreman, ASA.
Marotte, Martin, explosive handler, ASA.
Martin, David, utility mechanic, ASA.
Martin, Marvin, utility mechanic, ASA.
Matson, Jonathan E., Lt., station physician, NSFA.
Mattila, Edward G., heavy equipment mechanic, ASA.
McAvoy, Sharon, senior materialsperson, ASA.
McCabe, John A., CE2, NSFA.
McDonough, Robin E., SK2, NSFA.
McDowell, Russell, construction coordinator, ASA.
McGill, David M., DC2, NSFA.
McWilliams, Kimberly, boiler plant technician, ASA.
Michaels, Scott, work order planner, ASA.
Mickelson, James, equipment operator, ASA.
Mikesell, Matthew J., RM3, NSFA.
Miller, Brian, carpenter, ASA.

Miller, Nona, general assistant, ASA.
Miller, Roxana D., EO3, NSFA.
Miyoda, Larry, project engineer, ASA.
Mjolsness, Lawrence, maintenance supervisor, ASA.
Montanez, Federico I., SK2, NSFA.
Morales, James, ironworker, ASA.
Morehouse, David, inventory control specialist, ASA.
Morrow, Michael S., DC3, NSFA.
Mustain, Kenneth, plumber, ASA.
Nall, Kenneth T., MS1, NSFA.
Nelson, Catherine, clerk typist, ASA.
Nicholson, William, carpenter, ASA.
Nicoll, Robert, carpenter foreman, ASA.
Nolan, Paul, senior materialsperson, ASA.
Nugent, Ronald E., equipment operator, ASA.
Oylear, Dwight E., electrician foreman, ASA.
Paddock, Kathy, general assistant, ASA.
Palmer, Linda, carpenter, ASA.
Peat, Wendy, drafter, ASA.
Peckiconis, Jeanne, materialsperson, ASA.
Pettit, Joseph, project engineer, ASA.
Pierce, Jeffrey, insulator helper, ASA.
Pivin, Eric B., AG1, NSFA.
Poehler Jr., Donald, electrician, ASA.
Poehler Sr., Donald L., lineman, ASA.
Poole, Bradford, boiler mechanic, ASA.
Poorman, Russell, light vehicle mechanic, ASA.
Porter, David L., materialsperson, ASA.
Potter, Mark, lineman, ASA.
Price, William, insulator, ASA.
Profitt, Tinyia, general assistant, ASA.
Pruitt, Roy W., HMC, NSFA.
Putney, Kenneth L., ET2, NSFA.
Ransdell, Gary, facility maintenance engineer, ASA.
Richter, Allen, boiler mechanic, ASA.
Riker, Barbara G., materialsperson, ASA.
Riker, David L., materials foreman, ASA.
Ringlieb, Gregory J., drywaller foreman, ASA.
Robbins, James R., SW2, NSFA.
Robles, Sylvester L., electrician, ASA.
Rodriguez, Richard, RM1, NSFA.
Rogan, Michelle R., "Satellite observation and ionospheric studies," (S-051).
Rogowski, Kristine, general assistant, ASA.
Rose, Gene, painter foreman, ASA.
Ryan, Jeffrey, general assistant, ASA.
Sagaskey, Susan L., personnel coordinator, ASA.
Schilling, Darin J., preventive maintenance mechanic, ASA.
Schroeder, David B., DC3, NSFA.
Scott, Mark E., DS3, NSFA.
Segler, Richard L., utility mechanic, ASA.
Shanks, Clinton, small generator mechanic, ASA.
Sheldon, Lance A., DP1, NSFA.
Sheppard, James E., technical writer, ASA.
Short, Alice, senior clerk, ASA.
Short, Charles, scheduler, ASA.
Sislo, Bernard, carpenter, ASA.
Sliester, Randy D., utility mechanic, ASA.

## Sunset—South Pole Station, Monday morning, 23 March 1992

In March the Sun moves 1 degree to the north every 2½ days. The Sun's width is half a degree, so at the South Pole it takes 30 hours for the Sun to set: 30 hours from the time the bottom of the Sun touches the horizon until the upper rim finally disappears. This is the most leisurely sunset anyone on Earth will ever experience. The lower half of the Sun has been hidden in the dusty haze of blowing snow left over from the strong winds of Friday and Saturday (the flour-sized snow particles are so small they take days to settle), but we've had spectacular views of the upper arc.

The Sun entered the Northern Hemisphere on Friday evening, but we can still see it even today because of refraction with our temperature-inversion: the air temperature today is –62 °C at the surface but up 450 meters it warms to –34 °C.

I'm writing this letter by the big picture windows up in the Skylab lounge. The Sun no longer looks round; it's now a stack of three orange pancakes. The tops and bottoms of these cakes ripple with the wind. The left and right edges flash alternately yellow and green. Behind me, on the night side of the sky, the past-full Moon shines high and bright.

A great-circle boundary line separates the day half of the Earth from the night half. Today the South Pole is on that boundary. Look over to the Sun, just now that's the direction of Hawaii; in that time zone it's noon now. Look in the opposite direction to the dark sky, toward Botswana and Finland; in that time zone it's midnight.

We were treated to a fine show on Saturday evening. The entire Sun was still above the horizon, but it was giving us a farewell display that isn't supposed to happen until the upper rim sets. Green flashes came and went for an hour or so. From the green-fringed shimmering upper arc, green flakes would cleave off, rise, then vanish; sometimes two or three flakes would be following one another as if on a conveyor belt: as the top on disappeared another would rise from below. Then came the most amazing shocker that stunned us all: a triangular green cap perched on top of the orange disk; this little green pyramid was visible to everybody, not just through the binoculars. What a treat; there were some wide grins on those orange-glowing faces at the Skylab window!

—Stephen Warren, Department of Atmospheric Sciences, University of Washington. Dr. Warren is studying the optical and physical properties of the antarctic snow surface. His work during this austral winter focuses on measuring the spectral distribution of thermal infrared radiation from the atmosphere.

Smith, Eric B., drywaller, ASA.
Smith, Michael, MS2, NSFA.
Smith, Ross A., heavy equipment operations foreman, ASA.
Smith, Scott, plumber helper, ASA.
Spaulding, Kent M., sheetmetal worker, ASA.
Stanley, Thomas, senior materialsperson, ASA.
Stevens, Christopher S., SK2, NSFA.
Stevens, Scott B., painter, ASA.
Stine, James, incinerator mechanic, ASA.
Stokes, Ralph W., construction supervisor, ASA.
Stoll, James, heavy equipment mechanic, ASA.
Stonge, Marie T., RMC, NSFA.
Strong, Sherwood, electrician foreman, ASA.
Stuntzner, Todd, assistant supervisor, field center, ASA.
Sulyma, Robert, materials requisition specialist, ASA.
Thompson, Randall T., heavy equipment operator, ASA.
Thorne, Joyce, AC1, NSFA.
Todd, Philip, materialsperson, ASA.
Tortel, Paige, equipment operator, ASA.
Tracy, Lea Narden L., data-entry clerk, ASA.
Vissers, Harold, plumber, ASA.
Walter, Michael, boiler plant technician, ASA.
Walton, Debra, janitor, ASA.
Warner, Todd A., BU3, NSFA.
Warren, Cherie, janitor, ASA.
Welling, Matthew, refrigeration mechanic, ASA.
Wheeler, Brett, boiler plant technician, ASA.
White, Jerry F., preventive maintenance foreman, ASA.
Wiese, Lester W., CM1, NSFA.
Wilson, Victor G., DK1, NSFA.
Wright, Steven M., CE1, NSFA.
Zebroski, Steven, equipment operator, ASA.
Zippler, Kenneth E., EO3, NSFA.

**Palmer Station**

Baltz, Ronnie, materialsperson, ASA.
Fraser, James, science technician, ASA.
Frederick, Robert, station manager, ASA.

Graybill, Timothy, cook, ASA.
La Barre, Rob, physician, ASA.
Lindsey, Elizabeth, administrative assistant, ASA.
Norris, Wendy, data entry clerk, ASA.
Oxton, Alfred J., communications technician, ASA.
Schuldt, Dwaine, power plant mechanic, ASA.
Tarantino, Maria, assistant science lab supervisor, ASA.
Thomas, Scott, general assistant, ASA.

**South Pole Station**

Barlow, Roger A., "South Pole Satellite tracking and seismic programs," (S-052C).
Belinne, Daryl, science technician, ASA.
Carlisle, Betty, physician, ASA.
Doren, Darrell, inventory control specialist, ASA.
Freeman, Gary E., manager, South Pole, ASA.
Gaines, David, "South Pole Monitoring for climate change," (S-257A).
Getz, William, power plant mechanic, ASA.
Hughes, Kathryn M., meteorologist technician, ASA.
Johnson, Jerilyn, senior cook, ASA.
Koney, Robert, meteorologist, ASA.
LeDoux, Daniel J., science technician, ASA.
Logan, Andrew D., computer technician, ASA.
Mahoney, Paul, plumber, ASA.
Meis, James, communications technician, ASA.
Migliore, Joseph P., heavy equipment mechanic, ASA.
Starbuck, Michael, "South Pole Satellite tracking and seismic programs," (S-052C).
Stathis, Martha, materialsperson, ASA.
Surrey, Peter J., "South Pole air shower experiment," (S-109D).
Thompson, Jeffrey, communications coordinator, ASA.
Tysor, Dale H., "South Pole Monitoring for climate change," (S-257A).
Vonesh, John Lee, electrician, ASA.
Warren, Stephen G., "Climate sutdies at the South Pole," (S-265).

# Foundation awards of funds for antarctic projects, 1 January to 31 March 1992

Following is a list of National Science Foundation antarctic awards made from 1 January to 31 March 1992. Each item contains the name of the principal investigator or project manager, his or her institution, a shortened title of the project, the award number, and the amount awarded. If an investigator received a joint award from more than one Foundation program, the antarctic program funds are listed first, and the total amount of the award is listed in parentheses. Award numbers for awards initiated by the Division of Polar Programs contain the prefix DPP, and those by the Division of Ocean Sciences, the prefix OCE.

## Biology and medicine

Amos, Anthony F. University of Texas, Austin, Texas. Research on Antarctic Coastal Ecosystem Rates (RACER): Mechanisms of bloom formation and decline. DPP 89-07287. $38,282.

Baker, Bill J. Florida Institute of Technology, Melbourne, Florida. The chemical ecology of shallow-water marine invertebrates in McMurdo Sound, Antarctica. DPP 91-17216. $99,039.

Garrison, David L. University of California, Santa Cruz, California. Autumn ecology of the pack ice biota. DPP 91-17794. $82,595.

Gautier, Catherine. University of California, Santa Barbara, California. Spatial distribution of antarctic surface ultraviolet radiation from satellite and *in-situ* measurements. DPP 90-18207. $55,583.

Holm-Hansen, Osmund. Scripps Institution of Oceanography, La Jolla, California. Research on Antarctic Coastal Ecosystem Rates (RACER): Mechanisms of bloom formation and decline. DPP 88-17635. $131,913.

Howes, Brian L. Woods Hole Oceanographic Institute, Woods Hole, Massachusetts. Antarctic dry valley lakes: Pathways of organic matter production and decomposition. DPP 91-18363. $160,804.

Huntley, Mark E. Scripps Institution of Oceanography, La Jolla, California. Research on Antarctic Coastal Ecosystem Rates (RACER): Development, growth, and production of macrozooplankton, including krill. DPP 88-17779. $212,000.

Karl, David M. University of Hawaii, Honolulu, Hawaii. Research on Antarctic Coastal Ecosystem Rates (RACER): Microbial dynamics and carbon flux. DPP 88-18899. $81,978.

McClintock, James B. University of Alabama, Birmingham, Alabama. The chemical ecology of shallow-water marine invertebrates in McMurdo Sound, Antarctica. DPP 91-18864. $49,732.

Smith, Walker O. University of Tennessee, Knoxville, Tennessee. Production and regeneration of organic matter in the western Ross Sea. DPP 88-17070. $97,870.

Testa, J. Ward. University of Alaska, Fairbanks, Alaska. Physiological development and survival of juvenile Weddell seals. DPP 91-19885. $227,072.

Zapol, Warren M. Massachusetts General Hospital, Boston, Massachusetts. Physiological studies of free-diving Weddell seals. DPP 91-18192. $150,122.

## Marine and terrestrial geology and geophysics

Askin, Rosemary A. University of California, Riverside, California. Eocene terrestrial palynology of Seymour Island, Antarctica. DPP 90-19378. $43,165.

Butler, Rhett. Incorporated Research Institute for Seismology, Arlington, Virginia. Logistics support for global seismic station at the south pole. DPP 89-00340. $1.

Cassidy, William A. University of Pittsburgh, Pittsburgh, Pennsylvania. Antarctic search for meteorites. DPP 91-17558. $91,891.

Dalziel, Ian W. University of Texas, Austin, Texas. Tectonic evolution of the antarctic sector of the pacific margin: Mesozoic and paleozoic development of Marie Byrd Land II. DPP 89-17127. $89,000.

Elliott, David H. Ohio State University, Columbus, Ohio. Corridor Aerogeophysics of the Southeastern Ross Transect Zone (CASERTZ), Antarctica. DPP 89-19147. $217,435.

Elliott, David H. Ohio State University, Columbus, Ohio. Antarctic geophysical working group. DPP 90-11643. $13,152.

Feldmann, Rodney M. Kent State University, Kent, Ohio. Paleobiology of Late Cretaceous decapod crustaceans from James Ross Island, Antarctica. DPP 89-15439. $7,405.

Fisk, Martin R. Oregon State University, Corvallis, Oregon. Rifting and volcanism on the Antarctic Peninsula. DPP 88-17126. $7,448.

Hayes, Dennis E. Columbia University, Lamont-Doherty Geophysical Observatory, Palisades, New York. The Pacific margin of the Antarctic Peninsula: A marine geophysical study of the tectonic evolution of andean-type orogens. DPP 89- 17332. $97,877 ($125,819).

Lawver, Lawrence A. University of Texas, Austin, Texas. Antarctic marine heat flow. DPP 90-19247. $71,588.

Marsh, Bruce D. Johns Hopkins University, Baltimore, Maryland. Solidification front instability and silicic chaos in basaltic sills. DPP 91-17576. $60,000 ($90,000).

Mukasa, Samuel B. University of Michigan, Ann Arbor, Michigan. Tectonic evolution of the antarctic sector of the pacific margin II: Mesozoic and paleozoic development of eastern Marie Byrd Land. DPP 90-14854. $80,069.

Stump, Edmund. Arizona State University, Tempe, Arizona. Uplift history of the Transantarctic Mountains in northern Victoria Land. DPP 90-17763. $71,499.

### Ocean and climate studies

Amos, Anthony F. University of Texas, Austin, Texas. Research on Antarctic Coastal Ecosystem Rates (RACER): Mechanisms on bloom formation and decline. DPP 89-07287. $38,282.

Bromwich, David H. Ohio State University, Columbus, Ohio. Dynamics of antarctic mesoscale cyclogenesis. DPP 91-17448. $74,304.

DeMaster, David J. North Carolina State University, Raleigh, North Carolina. The preservation and accumulation of biogenic silica and organic carbon in a high-latitude environment: The Ross Sea. DPP 88-17209. $151,917.

Dunbar, Robert B. Rice University, Houston, Texas. Sinking and suspended particulate matter on the antarctic continental margin. DPP 88-18136. $71,209.

Foster, Theodore D. University of California, Santa Cruz, California. Antarctic bottom water formation. DPP 89-15730. $39,000.

Jeffries, Martin O. University of Alaska, Fairbanks, Alaska. Sea-ice physical-structural characteristics: Signature in the Pacific sector of the southern oceans. DPP 91-17721. $148,067.

Nelson, David M. Oregon State University, Corvallis, Oregon. Cycling of biogenic silica in the water column of the Ross Sea. DPP 88-17441. $228,560.

Warren, Stephen G. University of Washington, Seattle, Washington. Climate processes on the Antarctic Plateau. DPP 91-20380. $221,375.

### Astronomy, aeronomy, and astrophysics

Arnoldy, Roger L. University of New Hampshire, Durham, New Hampshire. An accomplishment-based renewal for support for measurement and analysis of high latitude magnetic pulsations. DPP 89-13870. $56,031 ($156,301).

Bering, Edgar A. University of Houston, Houston, Texas. Balloonborne studies of the ionosphere and magnetosphere above Antarctica. DPP 90-19567. $100,000.

Deshler, Terry L. University of Wyoming, Laramie, Wyoming. *In-situ* measurements of polar stratospheric clouds, condensation nuclei, and ozone in the springtime antarctic stratosphere. DPP 90-17805. $382,407.

Gaidos, James A. Purdue University, West Lafayette, Indiana. Observation of high gamma-ray sources from the South Pole. DPP 90-22723. $105,000.

Gaisser, Thomas K. Bartol Research Institute, University of Delaware, Newark, Delaware. South Pole air shower experiment for gamma-ray astronomy at ultra-high energy. DPP 91-17524. $149,000.

Helliwell, Robert A. Stanford University, Stanford, California. Investigations of mechanisms and effects of wave-particle interactions using data from Siple Station, Antarctica, very-low-frequency wave-injection experiments. DPP 89-18326. $46,311 ($146,311).

Helliwell, Robert A. Stanford University, Stanford, California. A continuation of logistics support for the operation of an extremely-low-frequency/very-low-frequency radiometer at Arrival Heights, Antarctica. DPP 91-19552. $5,293.

Hernandez, Gonzalo J. University of Washington, Seattle, Washington. Antarctic neutral thermospheric and mesospheric dynamics and thermodynamics. DPP 90-17484. $125,000 ($135,000).

Hudson, Robert D. University of Maryland, College Park, Maryland. Graduate student support for participation at the International Ozone Commission (IAMAP) 1992 Quadrennial Ozone Symposium. DPP 91-21742. $6,845 ($21,845).

Inan, Umran S. Stanford University, Stanford, California. Very-low-frequency remote sensing of thunderstorm and radiation belt coupling to the ionosphere. DPP 90-20687. $80,964.

LaBelle, James W. Dartmouth College, Hanover, New Hampshire. Low-frequency/high-frequency programmable frequency receiver to the antarctic automatic geophysical observatories. DPP 89-15635. $17,478.

Murcray, Frank J. University of Denver, Denver, Colorado. Infrared measurements in the Antarctic. DPP 89-17643. $30,414 ($60,414).

Pomerantz, Martin A. Bartol Research Institute, University of Delaware, Newark, Delaware. High-resolution helioseismology from the South Pole. DPP 89-17626. $116,660.

Smoot, George F. University of California, Berkeley, California. Low-frequency measurements of the cosmic microwave background radiation. DPP 90-18395. $64,473 ($106,473).

Stark, Antony A. Bell Laboratories, Murray Hill, New Jersey. A telescope for submillimeter spectroscopy from the South Pole. DPP 88-18384. $100,000 ($140,000).

Tinsley, Brian A. University of Texas, Richardson, Texas. Analysis of South Pole electric field data: Nature of variations related to sector boundary crossings. DPP 92-08937. $50,000.

### Glaciology

Bender, Michael L. University of Rhode Island, Narragansett, Rhode Island. Studies of the concentration and isotopic composition of oxygen, nitrogen and argon in trapped gases from the Vostok ice core. DPP 88-20807. $74,218.

Bender, Michael L. University of Rhode

## Weather at U.S. stations

| Feature | February 1992 | | | March 1992 | | | April 1992 | | |
|---|---|---|---|---|---|---|---|---|---|
| | McMurdo | Palmer | South Pole | McMurdo | Palmer | South Pole | McMurdo | Palmer | South Pole |
| Average temperature (°C) | −10.0 | 1.3 | −43.2 | −14.4 | −0.3 | −56.4 | −22.3 | −0.9 | −53.2 |
| Temperature maximum (°C)<br>(date) | −1.5<br>(3) | 6.4<br>(16) | −32.1<br>(1) | −4.0<br>(6) | 8.5<br>(5) | −43.7<br>(10) | −9.8<br>(18) | 5.7<br>(13) | −31.1<br>(26) |
| Temperature minimum (°C)<br>(date) | −21.3<br>(29) | −2.7<br>(28) | −55.3<br>(26) | −30.9<br>(31) | −7.9<br>(20) | −65.0<br>(16) | −33.0<br>(30) | −7.5<br>(12) | −68.5<br>(12) |
| Average station pressure (mb) | 997.53 | 985.50 | 688.60 | 985.41 | 989.10 | 681.80 | 987.20 | 992.50 | 680.00 |
| Pressure maximum (mb)<br>(date) | 1013.24<br>(18) | 1007.20<br>(17) | 697.90<br>(15) | 1003.79<br>(17) | 1006.40<br>(21) | 694.20<br>(19) | 1007.01<br>(19) | 1025.30<br>(18) | 696.00<br>(28) |
| Pressure minimum (mb)<br>(date) | 977.31<br>(9) | 965.60<br>(13) | 677.20<br>(11) | 971.22<br>(6) | 962.80<br>(17) | 672.00<br>(9) | 972.00<br>(14) | 961.00<br>(27) | 665.30<br>(21) |
| Snowfall (mm) | 25.40 | 297.00 | Trace | 248.92 | 698.00 | Trace | 45.72 | 642.00 | Trace |
| Prevailing wind direction | 50° | East | 50° | 70° | North | 70° | 50° | North | 80° |
| Average wind speed (m/sec) | 6.69 | 4.79 | 5.35 | 7.72 | 5.87 | 5.97 | 5.15 | 4.84 | 5.77 |
| Peak wind speed (m/sec)<br>(date)<br>(direction) | 20.59<br>(19)<br>(80°) | 26.77<br>(4)<br>(20°) | 19.09<br>(15)<br>(340°) | 28.83<br>(6)<br>(160°) | 29.86<br>(3)<br>(20°) | 13.41<br>(7)<br>(100°) | 19.56<br>(5)<br>(110°) | 35.01<br>(7)<br>(20°) | 16.54<br>(26)<br>(350°) |
| Average sky cover | 6.5 | 8.3 | 0.0 | 6.9 | 9.4 | 0.0 | 4.8 | 9.3 | 0.0 |
| Number clear days | 4.0 | 2.0 | 15.0 | 5.0 | 0.0 | 16.0 | 9.0 | 0.0 | 10.0 |
| Number partly cloudy days | 8.0 | 4.0 | 11.0 | 3.0 | 4.0 | 8.0 | 12.0 | 3.0 | 7.0 |
| Number cloudy days | 17.0 | 23.0 | 3.0 | 23.0 | 27.0 | 7.0 | 9.0 | 27.0 | 13.0 |
| Number days with visibility less than 0.4 km | 0.8 | 0.0 | 2.0 | 0.0 | 0.0 | 3.0 | 0.0 | 0.0 | 7.0 |

Prepared from information received from the stations. Locations: McMurdo 77°51′S 166°40′E, Palmer 64°46′S 64°3′W, Amundsen-Scott South Pole 90°S. Elevations: McMurdo sea level, Palmer sea level, Amundsen-Scott South Pole 2,835 meters. For prior data and daily logs, contact the National Climate Center, Asheville, North Carolina 28801.

Island, Kingston, Rhode Island. Studies of trapped gases in firn and ice from antarctic deep ice cores. DPP 91-17969. $83,475.

Bentley, Charles R. University of Wisconsin, Madison, Wisconsin. Radar studies of the bed of an active ice stream. DPP 90-18530. $115,778.

Denton, George H. University of Maine, Orono, Maine. Sensitivity of the antarctic ice sheet to Late Quaternary climate change. DPP 91-18678. $134,038.

Harrison, William D. University of Alaska, Fairbanks, Alaska. The measurement of temperature in the margin of ice stream B, Antarctica, and its interpretation. DPP 91-17911. $168,294.

Kamb, Barclay. California Institute of Technology, Pasadena, California. Studies of subglacial cores from the base of ice stream B, Antarctica. DPP 90-16631. $70,000.

Lal, Devendra. Scripps Institution of Oceanography, La Jolla, California. Nuclear studies of accumulating and ablation ice using cosmogenic carbon-14. DPP 90-17827. $53,508.

Meier, Mark F. University of Colorado, Boulder, Colorado. National ice core curatorial facility. DPP 90-16366. $160,720 ($321,440).

Mosley-Thompson, Ellen. Ohio State University, Columbus, Ohio. Long-term trend in net mass accumulation at South Pole. DPP 91-17447. $42,677.

Taylor, Kendrick. University of Nevada, Reno, Nevada. Electrical conductivity measurements at the McMurdo Dome core. DPP 91-17616. $77,110.

Wahlen, Martin. Scripps Institution of Oceanography, La Jolla, California. Measurements of gases in the Vostok ice cores. DPP 91-18534. $170,000.

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Smith, Christopher J. American Institute of Architecture, Washington, D.C. Interdisciplinary design competitions program. DPP 91-20809. $25,000.

Top, Zafer. University of Miami, Rosentiel School of Marine and Atmospheric Research, Miami, Florida. Operation SWAB: Monitoring of ship contamination. OCE 90-23376. $20,000 ($85,030).

Tumeo, Mark A. University of Alaska, Fairbanks, Alaska. Transport of hydrocarbon contaminants in ice and ice/soil systems. DPP 91-19559. $116,662.