PICO Bulletin

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FROM THE DIRECTOR'S DESK

by John Kelley

Five years ago, the University of Alaska Fairbanks (UAF) was awarded a contract from the National Science Foundation (NSF) to manage the Polar Ice Coring Office (PICO) for the NSF's Division of Polar Programs. Acceptance of the contract brought with it one of the most challenging and scientifically valuable projects in the history of PICO--the Greenland Ice Sheet Project 2 (GISP2). PICO's major task was to provide an electromechanical, cable-suspended ice-coring drill capable of producing a high-quality ice core through the Greenland ice sheet and into the underlying rock. It was also charged with providing support for the scientific team in Greenland and responsibility for transport of the core to the new National Ice Core Laboratory in Denver.

Although the small group of PICO personnel were initially burdened with the job of relocating their operations from the University of Nebraska at Lincoln and possessed only a prototype of the coring drill, their enthusiasm and dedication and the excellent support from UAF's professional schools overcame many of the initial challenges.

A project of this magnitude will usually bring with it many differences of opinion. However, a spirit of cooperation and dedication to the ultimate objective resulted in success.

Future scientific drilling, coring, and logistics support needs will present new challenges. I hope that these new challenges will be viewed not as problems but as opportunities to advance the state of technology, and will be treated with the same spirit of cooperation and collaboration so well demonstrated during the past five years.

Editor's Note: Dr. Kelley will return to his duties as Professor of Marine Science in the School of Fisheries and Ocean Sciences at UAF at the conclusion of the PICO contract.

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PROJECTS AT GREENLAND SUMMIT CAMP - 1994

With GISP2 coming to a successful close in 1993, activities at the Summit Camp will continue with a new objective. The 1994 season will consist of a major decommissioning plan and the support of six additional projects.

- **Air-Snow Exchange Investigations**
- **Automatic Weather Stations**
- **Borehole Temperature Logging**
- **Atmospheric Radio Noise Studies**
- **Measurement of Magnetic Field Fluctuation**
- **Ice Sheet Surveys**

PERSPECTIVES

COMING INTO ALASKA

by Luis Proenza

The team assembled under the PICO banner--The PICO Family--has more than shown its mettle! The successful completion of the U.S. ice-coring program under GISP2 and the superlative additional achievement of coring into bedrock will stand as a testimonial to what a group of dedicated

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COMING INTO ALASKA

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individuals can collectively accomplish. Congratulations are in order as also are some reminiscences and an expression of best wishes for the challenges ahead.

PICO in Alaska is an idea of simple power and logic because it is Alaska that leads the nation in polar science and technology. Indeed, it was important to position PICO closer to Greenland, and to position it precisely where it could provide the needed expertise for anticipated logistical requirements emerging from the new emphasis on the Arctic, as recognized by the National Science Board. The University of Alaska's campus in Fairbanks was not only a good choice, it was the only logical choice for the new PICO program. It had plenty of arctic scientists and saw that PICO could complement its already strong role as a place where the arctic science community gathered each field season.

As PICO made the transition from Nebraska to Alaska, a small group of individuals became smaller still. The challenges of GISP2, however, required additional personnel, and the PICO family continued to grow and evolve. As it did, PICO generated many positive transitions which, like all growing pains, were at times tumultuous and misunderstood. It is ironic that the Arctic, where cooperation is required for sheer survival, seems to call to itself strong individualists who do not often come together comfortably.

The PICO Family focused on the challenge and went beyond it. Through many trials, tribulations, and triumphs, it persevered and contributed to one of the most exciting pages in arctic science. And in service to the scientific community at large, PICO also made it possible for Alaska and its university to become a national resource.

Editor's Note: Dr. Proenza served as Principal Investigator of the PICO contract and currently serves the Statewide University of Alaska System as Acting Vice President for Academic Affairs and Research. Dr. Proenza also serves as Vice Chairperson of the U.S. Arctic Research Commission.

PROENZA APPOINTED VICE PRESIDENT AT PURDUE UNIVERSITY

University of Alaska Vice President Luis Proenza will leave Alaska on June 30, 1994, to become Vice President of Research and Dean of the Graduate School at Purdue University, West Lafayette, Indiana.

During Dr. Proenza's term at UAF, he helped develop an arctic research consortium (ARCUS) and was elected its first president. He also served as science advisor to Alaska Governor Walter J. Hickel and was appointed by former President George Bush as a member of the U.S. Arctic Research Commission.

THE FUTURE OF ICE CORE DRILLING: WHERE DO WE GO FROM HERE?

by Cornelius Sullivan

As the new Director of the Office of Polar Programs at NSF, I am glad to have the opportunity to provide a short article for the PICO Bulletin. Before looking toward the future of ice core drilling in the U.S., let me add once again my congratulations to those of you who made the GISP2 deep ice core drilling program a success.

With the recent completion of drilling the longest ice core to bedrock (3053 m) at Summit, Greenland, as part of GISP2, it is worth a moment of reflection on just how far we have come in the last five years and where we would like to be five years from now.

PICO has demonstrated that the U.S. is capable, once again, of deep ice core drilling. In addition, the U.S. ice-coring community has blossomed in the last several years from a few isolated investigators working in their own labs to a coherent group of researchers at the forefront of their science (note the many recent articles in high-profile journals such as *Science* and *Nature*). We now have a proven deep ice core drill and a multidisciplinary collection of principal investigators and graduate/undergraduate students with both field and laboratory experience in ice core handling and analysis. As well, we just recently dedicated the new U.S. National Ice Core Laboratory in Lakewood, Colorado.

Although the GISP2 ice core drilling is complete, there are still many years of analysis ahead to unravel all of the secrets locked in the ice cores. Based on the preliminary results I have seen, these studies promise to revolutionize our thinking on climate change and particularly glacial/interglacial cycles. In addition, in the near future we hope to be able to undertake a program of intermediate and deep ice core drilling in West Antarctica to provide a Southern Hemisphere analog to the GISP2 core.

PICO PERSPECTIVE

by Herman Zimmerman

I thought it was to be easy. Ice coring had been going on for 20 years. Camp Century, Dye 3, Byrd Station, and Vostok had all been done. My American Geophysical Union volume of GISP at Dye 3 had grown a little cover of dust. So drilling another hole at Summit in Greenland shouldn't be too hard--a piece of cake!

By 1986 the science had already been pretty well defined for the second GISP effort; the recovery of a paleo-atmospheric record in ice cores provided the impetus for the new effort. The improvements needed in the coring system seemed to be a simple stepwise modification on an already successful design--"just a little bigger, just a little better." That's what it looked like from inside the beltway in 1987, so I thought it would be easy.

Six years later, my perception from inside the beltway is that it wasn't so easy, but the GISP2 results were indeed worth the effort. I would do it again. Perhaps I would change a few things, but all things are easier with 20/20 hindsight. In my view, the NSF's GISP2 and Europe's Greenland Ice Project (GRIP) have been the premier field projects over the last half decade. I cannot think of another recent effort that has produced such far-reaching results with such global impact.

Interest in global change was just gathering steam in 1987, and the need for an accurate record of the paleo-atmosphere was self-evident to increase our understanding of the earth's changing climate. GISP2 and GRIP have achieved that objective. As often happens, however, it is the unexpected result that generates the most excitement and leads to the next level of understanding. For GISP2, it is the finding that atmospheric conditions emerging from the last ice age shifted twice from a glacial to an inter-glacial mode in an astonishingly swift three to five years.

These results have moved the paleoatmospheric sciences into a central role within the U.S. Global Change Research Program and present a challenge to the climate-modeling community. Predictive models will be much more effective for policy decisions when they can accurately simulate altered climate states of the past.

Editor's Note: Dr. Zimmerman, presently Program Manager, Climate Dynamics Program, Division of Atmospheric Sciences, NSF, formerly managed the PICO contract as Program Manager, Division of Polar Programs, NSF. Dr. Zimmerman also serves in PAGES, Core Project Office, Bern, Switzerland.

TRADITION IN THE CHALLENGE

by Herbert T. Ueda

The history of ice core drilling has been fraught with years of struggling and frustration interspersed with occasional moments of triumph. The realization of those rare moments were made possible through the perseverance and dedication of numerous distinguished individuals over the years. The pioneering work of L. Hansen at CRREL in the 1960s was followed in the 1970s by the Russian scientists at Vostok and in the 1980s and 1990s by the notable accomplishments of H. Rufli, N. Gundestrup, and S. Johnsen among the many Europeans in Greenland and Antarctica. To this list we now can add the people of PICO/UAF with their monumental achievement at Summit, Greenland. They followed in the tradition of those before them in overcoming some very adverse situations before reaching their goal. Perhaps soon to follow will be the Australians and Japanese, among others, in their forthcoming programs.

In the past five years, under the leadership of John Kelley, PICO has met the tasks and challenges imposed on it by the glaciological community. PICO's dedication and innovative efforts have resulted in significant contributions in the area of polar logistics, in providing the tools to enhance the researcher, and in the furtherance of ice drilling and sampling. PICO will undoubtedly see a continuation of the accomplishments and successes of the past.

Editor's Note: Herbert Ueda is an engineer retired from the U.S. Army CRREL. He led the PICO Technical Services group at the beginning of the PICO program at UAF.

DEVELOPMENT OF DEEP ICE CORING

by Henri Rufli
(summarized from a letter to the editor)

My first experience with drilling in ice was in 1958 with a commercial drilling company in Zermatt, Switzerland. The company wanted to ascertain the bedrock profile of a glacier for a water supply tunnel and hydroelectric plant using conventional rock-drilling equipment.

In the summer of 1971, I learned thermal core drilling at Dye 3 along with Paul Theodorsson from Iceland and John Rand from CRREL, under the instruction of Lyle Hansen.

Our institute was more interested in melting the ice to obtain air samples than in drilling, itself. However, I was ordered to build a drill for our own drilling at Byrd Station, Antarctica, during 1971-72. Other than the SIPRE auger, almost no lightweight coring equipment existed at that time.

With an increasing need for ice core data within the scientific community, John Rand and I decided to build an electromechanical drill, suspended from a cable to keep downhole weight low compared with devices which required a number of extensions. Such a drill would not disturb the core with meltwater. First tested in 1973, this type of ice-coring drill with modifications has been used now for 20 years. In 1977 I had occasion to drill a water-filled crevasse on a glacier in Austria. As a result of this experience, I felt it should be possible to build a deep drill based on the shallow-drill principle.

I discussed this with Bruce Koci and Scott Watson--that such a drill was possible to build, using a disconnecting core barrel and outer barrel and adding a pump and filter to collect the ice chips. Results of this discussion led to the development of the U.S. drill with which PICO drillers reached bedrock through the Greenland ice sheet in 1993.

Future modifications will allow ice cores to be produced more quickly and efficiently, at less cost. For example, the recent development of a new drilling fluid and cable helped to get the job done in Greenland. And, it was a *great* job.

Editor's Note: H. Rufli is an engineer with the Physikalisches Institut, University of Bern in Switzerland. He provided much valuable advice during the early stage of development of the deep drill used for GISP2.

FROM HAND AUGER TO DEEP CORING IN A FLUID-FILLED HOLE

by Bruce Koci, Senior Engineer, PICO

Development of the PICO deep drill began with construction of the hand auger in the early 1980s. Efficient cutters and core-breaking devices served to minimize power requirements and cable load thus keeping operating machinery at a reasonable size. These developments were carried over to the 4-inch electromechanical system, where they enabled us to drill anywhere on this planet.

Dry-hole drilling is limited by core fracture which is a result of bubble pressure within the ice. Presence of fluid in the hole cures the problem without resorting to mechanical perfection. Amazingly, it was the presence of fluid in small quantities that prevented fracturing.

Drilling in a fluid required only the addition of a pump and means of filtering chips from the slurry. As a result, a new modular dry or wet drill was proposed with an increased core diameter to give twice the core volume. The increase in diameter permitted use of more robust mechanical components which permitted drill design to include the possibility of coring subglacial material and rock.

Proof of the concept was demonstrated at the University of Nebraska, CRREL, and finally by PICO in Greenland during the summer of 1989. Core quality was good from the beginning, but industrial engineering problems associated with uphole handling and switching of drilling fluid from petroleum-based fluids to n-butyl acetate had to be worked out. Finally the drill did what it was supposed to do; it cored to the bottom of the ice. With the aid of a newly developed rock-coring modification, this cable-suspended drill was successful in coring into the bedrock.

Bruce Koci (left) and Fucheng Li (Photo by Seth Danielson)

ACKNOWLEDGMENTS

by John Kelley

Throughout GISP2, and especially during its early field period in Greenland, PICO received invaluable and generous assistance from the science program investigators and the Science Management Office (SMO) at the University of New Hampshire headed by Dr. Paul Mayewski. The advice from the SMO was helpful in shaping PICO's future course of action.

With the successful conclusion of GISP2, my first thoughts were to express deep gratitude to the men and women who made all of this possible. Although recognition was accomplished in various reports and memoranda, I would like to reminisce a bit.

Jay Sonderup, Kent Swanson, and Bruce Koci relocated from the University of Nebraska at Lincoln (UNL) to the UAF at the inception of the PICO contract. They were joined by Herb Ueda, a recently retired engineer with many years of experience in ice drilling from the U.S. Army CRREL in Hanover, New Hampshire. Jay Klinck, who carried out an effective camp management program at the GISP2 site in Greenland, and Jay Kyne also joined PICO during its first year. Dr. Walter Hancock, who designed the instrumentation for the deep ice-coring drill, remained in Nebraska but played a vital role especially in the field throughout the GISP2 program and in Antarctica. Dr. Hancock was also offered affiliate faculty status in the UAF School of Engineering.

PICO staff at Sondrestrom and GISP2 - spring 1993. (Photo by Lars Iversen)

This small group together with the business staff in the office of Dr. Luis Proenza, Vice Chancellor for Research, were faced with the transition of activities from UNL, carrying out PICO activities in Greenland, and with drilling and coring tasks elsewhere. Their dedication was enthusiastic and invaluable.

Key to the success of the development of the deep ice-coring drill were the excellent services of Larry Kozycki, supervisor of the Geophysical Institute Machine Shop, and his associate Ned Manning. I remember with great fondness the highly spirited conversations between Larry and the PICO staff and the much valued interaction with Henri Rufli of the University of Bern, Switzerland.

Mark Wumkes joined PICO in 1990 and very competently carried much of the burden of the design as well as leadership of the coring project in Greenland to the conclusion of GISP2.

PICO was assisted at UAF by an advisory committee comprised of interested faculty from the professional schools. Individual faculty members directed the research interests of their graduate students to problems associated with drilling and coring, logistics, and facilities construction on ice and snow. Through Professor Terry McFadden's interest in PICO, exchange students from Luleå University in Sweden completed master's degree projects related to PICO engineering needs.

PICO support requirements offered an excellent opportunity to improve on how logistics services could be offered in support of future projects in the Arctic. Initial discussions and research related to logistics management systems began in the School of Engineering. We recognized that an effective and comprehensive logistics information system was essential to improving project support activities in the Arctic. Furthermore, employment of expert systems would enhance the usefulness of the system.

Scott Jackson, PICO Logistics Manager, and Shawn Abshear, System Administrator, developed Phase I of the Value-Added Logistics Information System (VALIS), which is now operative and provides needed communication and information links between remote sites via satellite.

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ACKNOWLEDGMENTS

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Critical to the development of the deep ice-coring drill was the provision of an environmentally and scientifically acceptable drilling fluid. Early in the program, several fluids were suggested, but it was the extensive research of Dr. Thomas Gosink at the Institute of Marine Science, UAF, who demonstrated the merits of using n-butyl acetate.

Close association with the NSF has been essential; many there contributed to the PICO program and its ultimate success. Chief among them was Dr. Herman Zimmerman whose tireless efforts and keen understanding of the project's many facets enabled PICO to achieve its goals. Dr. Zimmerman's efforts to establish a working relationship with the Institute of Geography at the Russian Academy of Sciences in Moscow, led to PICO's association with Dr. Victor Zagorodnov and Dr. Oleg Nagornov, which continues to the present time.

Our alliance with the European Greenland Ice Project and Dr. Niels Gundestrup has been a source of great satisfaction and good will which shall be well-remembered. This spirit of international cooperation also resulted in producing a rock core from beneath the Greenland ice sheet at the GISP2 site.

Simultaneous with the work during the past five years and successful completion of GISP2, PICO staff has been engaged in the support of many other projects worldwide. These include a deep-drilling project at McMurdo Dome, Antarctica, carried out by Dave Giles and his staff during austral summer of 1993-94 (see page 11). Yet another major task from the NSF has been the development of a neutrino and muon detection system (AMANDA) at the South Pole Station, Antarctica, under the direction of Dr. Robert Morse of the University of Wisconsin (see page 12). PICO is providing support for this multi-hole array by using a hot-water drilling system under the direction of Bruce Koci. Organizations other than the NSF have utilized PICO's services. Particularly acknowledged is the long association with Dr. Lonnie Thompson's (Ohio State University) NOAA-supported coring project in Peru and China (see page 8).

The PICO project at the UAF has made possible many opportunities for the development and enhancement of arctic research technologies by many talented and dedicated individuals. This includes individuals who are accomplished in their professional fields as well as those working at intern levels. PICO provided opportunities for undergraduate and graduate student training

	GISP2					McMurdo Dome
EMPLOYEE	1989	1990	1991	1992	1993	Antarctica
Albershardt, Lou				•	•	•
Barber, Bill		•	•			•
Bergeron, Beth				•	•	
Bergman, Karl			•	•	•	•
Burton, Tyler		•				
Capelle, Laura				•		
Collins, Jesse			•		•	•
Danford, Bill		•		•		
Danford, Julia				•		•
Danielson, Alice			•			
Dausel, Dave				•		•
Deboer, Harm			•			
Gacke, Terry	•	•	•	•	•	
Galanes, Lynn				•		
Gallagher, Patrick				•		
Giles, Dave		•	•	•	•	•
Gwynn, Maureen			•			
Hall, Swede				•		
Hancock, Walt	•	•	•	•	•	•
Harrington, Mark			•	•		
Heimann, Jim				•		
Kahler, Don				•	•	•
Kalous, Joe		•				
Klinck, Jay	•	•	•	•	•	•
Koester, Dave		•	•			
Kyne, Jay	•				•	•
Lamont, Sam		•				
Larson, Travis		•	•			
Lawson, Brian			•			
Melville, Catherine		•	•	•		
Purdy, Ray					•	
Prescott, Barb			•			
Prestridge, Lesia		•	•		•	
Price, Craig					•	
Shenton, Ned				•		
Shields, Joe				•		
Stanford, Kerry			•			
Sturges, Sarah		•	•	•		
Walters, Aaron			•		•	
Weyhenmeyer, C.				•		
Wilson, Bruce			•	•		•
Wumkes, Mark		•	•	•	•	

PICO personnel who worked at the GISP2 Summit camp in Greenland and at McMurdo Dome, Antarctica.

REPORTS

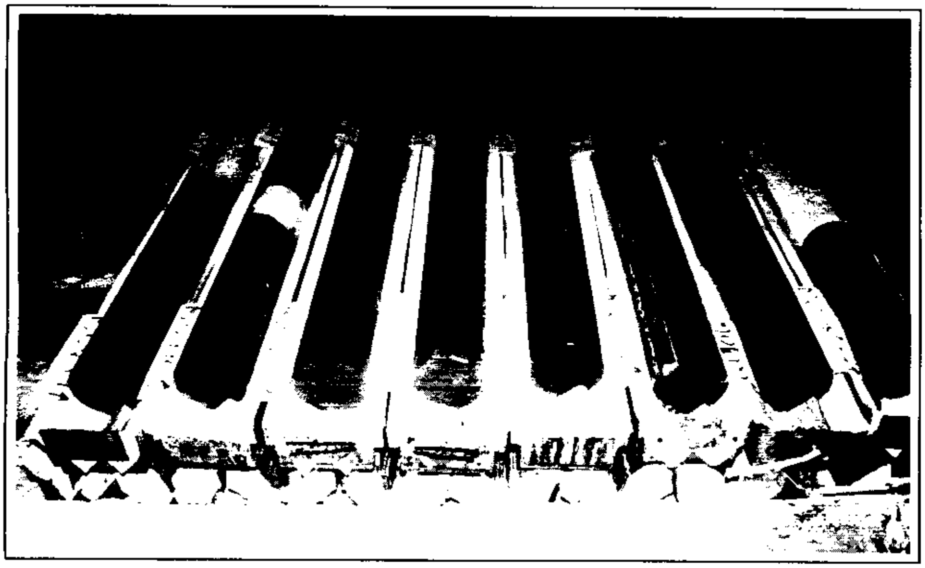
GISP2: DRILLING FINISHES, EXCITEMENT BEGINS

by *Michael Morrison and Paul Mayewski*

On July 1, 1993, Paul Mayewski, Chief Scientist of the National Science Foundation's Greenland Ice Sheet Project Two, and Mark Wumkes, PICO's Chief Driller for the project, reported from the drilling site at the summit of the Greenland ice sheet that coring had reached bedrock at 3053 m. This achievement came after many years of effort on behalf of institutions and researchers around the U.S. The effort has been well spent. The result will be the longest, most detailed, most extensively and broadly analyzed continuous record of climate from the Northern Hemisphere ever retrieved. The 3053-m core is expected to yield a 250,000-year climate history. Because of the high accumulation rates at the drilling site and the core's location near the ice divide (72°N, 38°W), a picture of climate in unprecedented detail has already been revealed. (For some recent examples, see Alley et al., *Nature*, 8 April 1993, p. 527; Mayewski et al., *Science*, 9 July 1993, p. 195; and Taylor et al., *Nature*, 4 February 1993, p. 432.) To date, 24 papers have been published as a direct result of GISP2 and at least 8 more are in press. A listing of papers so far may be obtained from the GISP2 Science Management Office (SMO) at the University of New Hampshire (UNH) (Address: GISP2 SMO, EOS - UNH, Durham, NH 03824-3525 USA).

With ice samples now filling the laboratories of the 20 or so institutions and laboratories around the U.S. and new data sets emerging daily, excitement about the new understanding of climate is growing. Even with only two-thirds of the core that had been analyzed prior to this summer's drilling, GISP2 has revolutionized humanity's perspective on climate and the role of human activities on climate change. We now know that climate change can occur rapidly and dramatically between glacial and interglacial conditions over time periods of 3 to 50 years. We know that the last 11,000 years have been remarkably stable, and we know that human activity has significantly altered components of the atmosphere which we observe to change with historical climate changes. We now see human industrial activity providing a "kick" to the climate which has a demonstrated capacity for dramatic (and for current human society, catastrophic) change, but which is currently stable and favorable. While researchers from GISP2 (and the European companion project, GRIP) hope to eventually understand the specific mechanisms of climate change and be able to make predictions about the kind of changes we may expect, it is clear at this time that human industrial activity is very likely to cause changes and that those changes may be severe.

GISP2 is coordinated by the GISP2 Science Management Office at UNH. Drilling development and support and logistics are provided by PICO at the University of Alaska Fairbanks. All materials are transported to camp on ski-equipped LC-130 aircraft owned and operated by the 109th Airlift Group of Scotia, New York.



The final ice cores extracted from the GISP2 borehole display the interface between clear and silty ice.
(Photo by Jay Klinck)

EXPEDITIONS TO LOW-LATITUDE GLACIERS

by Bruce Koci, Senior Engineer, PICO

During the summers of 1992 and 1993, PICO, working with Dr. Lonnie Thompson of the Byrd Polar Research Center at The Ohio State University, completed coring two more sites on a proposed global network of low-latitude, high-altitude glaciers. We have now successfully completed drilling four sites in a program that began in 1983. Information obtained from cores is unique because it comes from regions of this planet that are driving the climate. These glaciers, because of their small size, respond quickly to any change in conditions. While the emphasis has been on detailed records that cover the last 2000 years, it appears that the last two records are considerably longer. All the data so far suggest that global warming is real. The Quelccaya ice cap, originally drilled in 1983, no longer contains a record because of warming.

In 1992 we journeyed to far western China to the Guliya ice cap located in the Kunlun Mountains on the Tibetan Plateau. Remoteness and altitude made this the most logistically challenging attempt at coring these sites to date. The summit of the ice cap is located at 6700 m. Fortunately, the main drill site was only 6200 m. Combinations of wind, intense sun, and thunderstorms (where are you going to hide?) made drilling more interesting. In the end, cores of 82 and 309 m were retrieved and successfully returned in a frozen state to the Lanzhou Institute of Glaciology and Geocryology in China and The Ohio State University.

Three drills were required to complete the 309-m hole because of hole closure problems and brittle ice. The PICO 4-inch drill provided core to 200 m, where a PICO thermal drill and a Russian thermal antifreeze drill supplied by Dr. Victor Zagarodnov were used to complete coring the final 109 m of ice.

In 1993 we climbed Huascaran in Peru. While logistics lines were much shorter, the ascent was steep and we had to climb through an icefall in an earthquake zone. Solar power was used to power a PICO thermal drill, and the Russian thermal antifreeze drill was again supplied by Dr. Victor Zagarodnov. Two holes approximately 160 m deep were completed with one core being melted and returned as water samples while the other was returned safely in a frozen state. Indications are that ice near the base has an age greater than 10,000 years B.P. Preliminary investigations by Dr. Thompson suggest that the tropics cooled by 6°C rather than the previously suspected 1.5°C. Recent evidence from shallow ocean sources confirms this finding.

Drilling in China was a cooperative effort with the Lanzhou Institute of Glaciology and Geocryology. Funding was provided by the NSF's Climate Dynamics Branch. Drilling in Peru was a cooperative effort with Electro Peru and a group of mountain guides led by Benjamin Vincencio. Funding was provided by a grant from the National Oceanographic and Atmospheric Administration.

Greenland peregrine falcon and chicks.
(Photo by Bill Mattox)

GREENLAND FALCON STUDY - -THE 22nd YEAR

In 1972, Dr. Bill Mattox and three associates began their first detailed study of peregrine falcons in Greenland. At that time, there was very little information on peregrines in Greenland and great concern (since the 1960s) over potential extinction of these birds. In 1972, 9 pairs of peregrines were located with 18 young. Nineteen years later, in 1991, 69 pairs were found with 191 young. The average young per pair increased from 1.88 to 2.77, the higher reproduction apparently resulting from reduced contamination of DDT.

More than 1300 peregrines have been banded, producing information on migratory routes and wintering areas in Latin America. Additional information includes fidelity to habitat and to each other, as well as mortality rates. Recently, small amounts of blood were collected and analyzed for a genetic DNA marker which may provide information for identifying Greenlandic peregrines on migratory routes and wintering grounds.

Work has been expanded to the gyrfalcon, and its movements have been tracked by satellite.

To date, more than 70 individuals, including Greenlandic residents, have participated in this project. The PICO logistics office at Kangerlussuaq assisted with field support.

From The Peregrine Fund Newsletter, No. 21

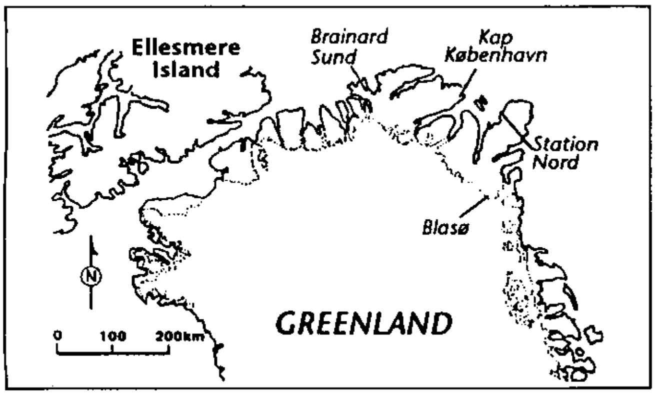
HERBIVORES IN THE HIGH ARCTIC

by David Klein

A joint U.S./Danish research team, investigating adaptations of High Arctic herbivores to constraints on plant growth in the world's northernmost land area, carried out field work in Nansen Land, northern Greenland, during July and August 1991. Dr. David Klein, Alaska Cooperative Wildlife Research Unit, University of Alaska Fairbanks, and Dr. Christian Bay, Botanical Museum, University of Copenhagen, measured plant productivity, mapped its distribution, and collected samples of key food plants for analysis of nutrient value and tannin levels for comparison with similar species growing at lower latitudes. Patterns of use of the vegetation by the major vertebrate herbivores, musk oxen, Arctic hares, collared lemmings, and ptarmigan were recorded by direct observation, sampling of vegetation types for frequency of summer and winter fecal pellets, and analysis of diet composition by microhistological examination of feces. Differences in patterns of use of vegetation by the herbivores associated with differences in body size, digestive tract morphology, mobility, and behavior appear to limit the extent of direct competition between species for available plant food.

The study area is a broad valley extending across Nansen Land from Brainard Sund to J.P. Koch Fjord (82°57'N, 41°25'W) and was chosen based on National Oceanographic and Atmospheric Administration satellite data indicating that plant productivity was among the highest for all of northern Greenland. The high plant productivity stems at least partly from isolation of the area from cold Arctic Ocean influences by surrounding high mountains and high clay content in the soils that retains the limited moisture in this arctic desert for plant growth.

Financial support for this research is from the Danish National Science Council, the Danish Polar Center, and the U.S. National Science Foundation. PICO assisted with administration of the logistics.



Dr. David Klein taking measurements from the skull of a musk oxen that had died years earlier. Skeletal remains of musk oxen in the polar desert of northern Greenland may persist for hundreds of years.

PICO PROVIDES LOGISTICS SERVICES FOR FLUX PROJECT

by Baxter Burton, Assistant Director, PICO

Beginning in 1994, PICO will start providing the logistics support for the Flux Study being conducted on the North Slope of Alaska. Flux, as it is called, is a branch of the Land, Atmosphere, Ice Interaction (LAII) Program of the NSF's Office of Polar Programs and will be combined with data from Ocean, Atmosphere, Ice Interactions (OAII) to provide scientists a basis to "understand the physical, chemical, biological, and social processes of the Arctic system that interact with the total Earth system and thus contribute to or are influenced by global change."

Flux involves nine principal investigators and is a ten-year program to study "greenhouse" gas fluxes, albedo changes, and nutrient fluxes in order to produce a model of change over time of arctic plant and animal communities.

The initial studies will be conducted at Toolik Lake, Happy Valley, Barrow, and Prudhoe Bay. The first several seasons will focus primarily on the Kuparuk Basin, where the principal investigators hope to create a detailed model which they can then scale up to the Alaska Arctic, North American Arctic, and eventually, the Circumpolar Arctic.

For 1994, PICO will be coordinating helicopter charter time and Toolik user-days, obtaining permits, and establishing a small field camp at Happy Valley. However, we fully expect the logistics requirements to hit full stride beginning in 1995, which means the exceptional team UAF built during GISP2 will have the opportunity to continue to provide NSF with the professional logistics services it and the scientific community have come to expect.

HOT-WATER DRILLING FOR THE AMANDA PROJECT

by Bruce Koci, Senior Engineer, PICO

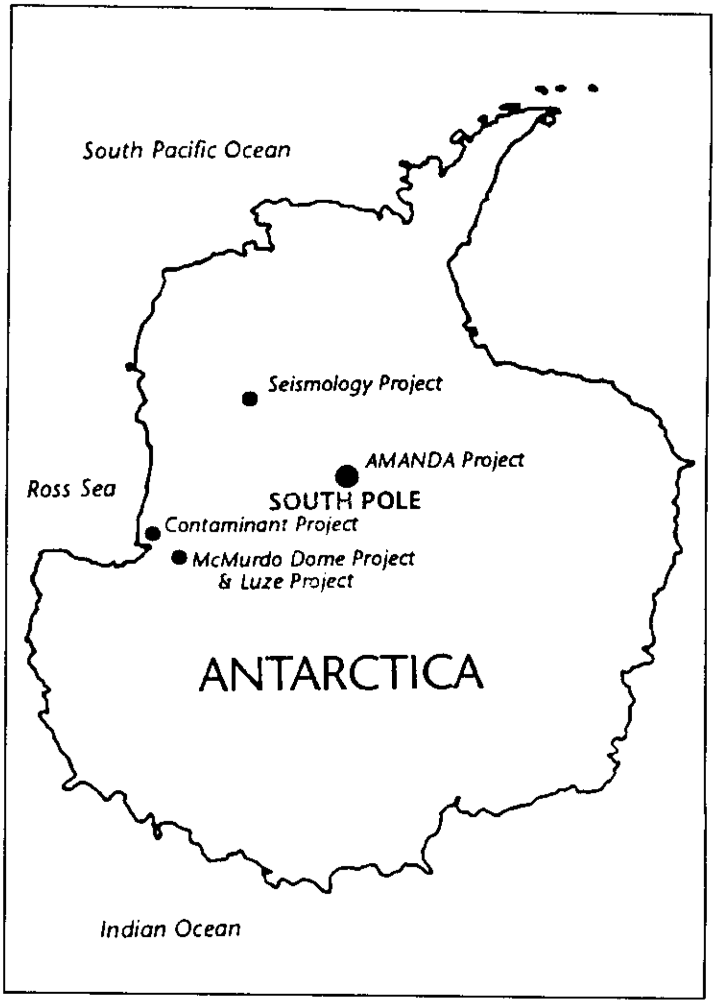
While the detection of neutrinos is scientifically "interesting," drilling 1-km-deep holes 0.5 m in diameter that are vertical within 0.1° presents its own set of challenges. Since mechanical drilling is inherently unstable, thermal means are selected to provide a straight vertical hole.

PICO's experience in hot-water drilling for cold ice began in 1979 at Dome C with a maximum hole depth of 100 m. Since then, we have expanded the system by adding modules and instrumentation to increase depth capability and more fully understand the drilling and refreezing process. During the 1991-92 austral summer, a scaled-down prototype version of the current drilling equipment was used to demonstrate the feasibility of drilling deep holes in very cold ice and have the photomultiplier tubes (PMTs) survive the refreezing process. The process worked, and we embarked on a development project resulting in the current drill for the AMANDA (Antarctic Muon and Neutrino Detector Array) project.

During the past field season, 4 holes were drilled, and strings of 20 PMTs were lowered into each. The current system supplies 1100 kW of heat through a 3-cm-diameter hose. A separate cable controls tension and provides the information loop through which inclination, nozzle temperature, orientation, hole diameter, and a host of other parameters are monitored by computer and displayed.

Since the season was successful, we intend to make minor corrections by adding 20 percent more heat (you can never have too much heat in hot-water drilling), providing equipment shelter, and refining the instrument package. Future plans call for drilling between 70 and 100 holes, possibly to depths of more than 1500 m, which can take 40-cm-diameter PMTs. Fuel costs at the South Pole are high, so we are considering a solar alternative. At this point, it appears to be attractive since direct beam radiation is in excess of 1 kW/m^2.

This system can be adapted to subice sampling (both till and bedrock) using standard coiled tubing methods and technologies. Water as a drilling fluid represents an attractive substance from an environmental standpoint. Potentially, this type of system has the capability to drill more than 1 km into rock beneath the ice through more than 2 km of ice.



DRILLING IN ANTARCTICA

A PICO team led by Jay Kyne drilled nine holes near Williams Field, Antarctica, in support of a fuel-spill contamination study conducted by Dr. Mark Tumeo of the School of Engineering, University of Alaska Fairbanks. The team, which included Jay Klinck and Kerry Stanford, carried out the project during January 1994.

Jay Kyne and Jay Klinck also drilled 107 holes in support of a seismology project conducted by Dr. Charles Bentley of the University of Wisconsin.

PICO DRILLS THROUGH THE ANTARCTIC ICE AT McMURDO DOME

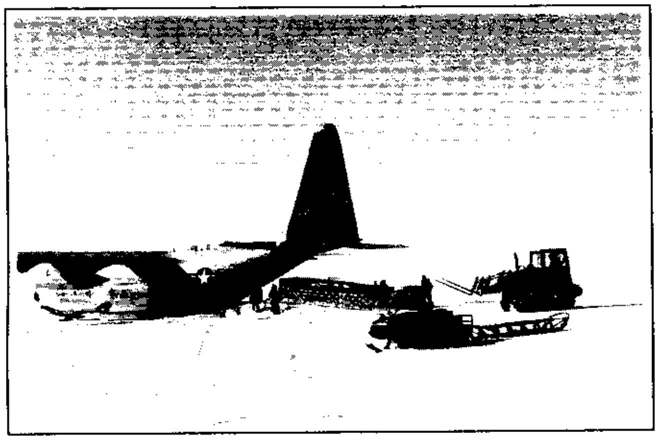
by Dave Giles, Field Engineer, PICO

The PICO Engineering Department successfully completed a 5.2-inch ice-coring project at McMurdo Dome, Antarctica, during the 1993-94 austral summer. The 554.31-m-deep hole was in support of Dr. Pieter Grootes at the University of Washington. Other participants were Dr. Joan Fitzpatrick of the U.S. Geological Survey in Denver and Dr. Ed Waddington of the University of Washington.

After completing a 3053-m-deep hole in Greenland in July 1993, the drill was sent directly to Antarctica. After arriving on site (at 158°43'49.40"E, 77°47'03.36"S), the PICO crew set up the drill structure and began drilling less than four weeks later. The drilling was able to begin quickly because no protective structure was built around the drill. Other than for the electronics in the control room, the entire drill structure was open to the weather (see photo). The challenge for PICO on this project was to set up the drill, drill completely through the ice sheet, and disassemble and retrograde the drill system all in one year. The project was completely successful because even the tower anchors were removed and retrograded. The only thing that we left behind was the cased hole.

This project could not have been successful without the active and continued support of Antarctic Support Associates. The aircraft were operated by the U.S. Navy VXE-6 Squadron and the 109th TAG New York Air National Guard.

5.5 meters of core in one piece with core handlers Jill Turner and Kiym Cunningham. *(Photo by Dave Giles)*



The drill string is loaded onto a NYANG 109th TAG LC130 for the flight to McMurdo Station at the end of the drilling season. *(Photo by Dave Giles)*

The complete drill structure showing the toolroom/shop on the left and the generator shack on the right. *(Photo by Dave Giles)*

HUNTING NEUTRINO PULSARS USING THE SOUTH POLE ICE CAP

by Robert W. Morse

Scientists from the University of Wisconsin-Madison (UW-Madison) and the University of California at Berkeley (UCB) and at Irvine (UCI), in collaboration with PICO, have embarked upon a plan to transform the South Pole ice cap into a neutrino telescope. By drilling holes into the two-mile-thick polar ice cap, they plan to take advantage of this deep, clear ice. It is at these great depths that they plan to position the light-sensitive detectors that make up this different kind of telescope which will search for the origins of interstellar neutrinos, those ghostly subatomic particles believed to emanate from distant black holes, pulsars, and quasars.

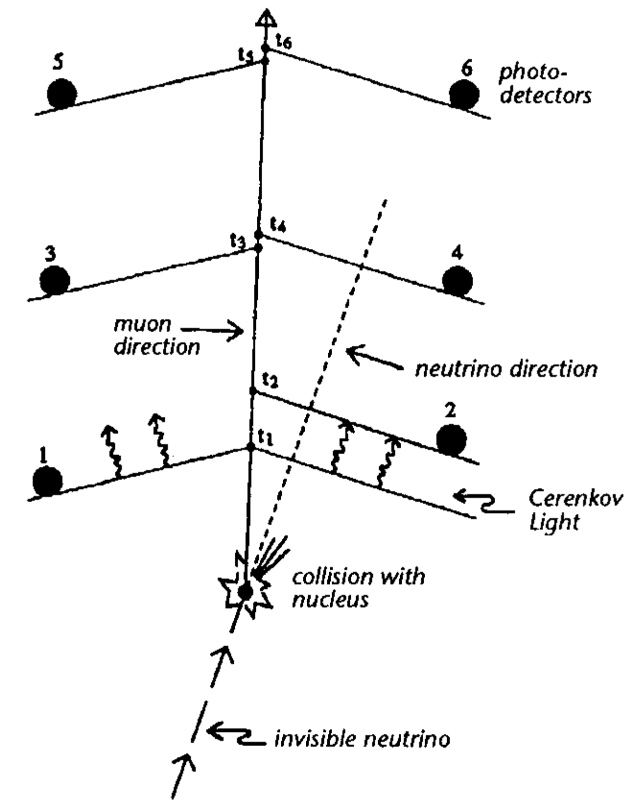
This experiment (known as AMANDA for Antarctic Muon and Neutrino Detector Array) got underway during the 1991-92 season at South Pole Station when scientists and drillers from PICO, using hot-water hoses, began drilling holes more than half a mile deep into the polar ice cap. Into the holes, the scientists placed strings of sensitive detectors designed to catch the fleeting flashes of light created when a neutrino particle interacts with the nucleons in the ice. AMANDA will be situated almost exactly at the South Pole, very near the large geodesic dome that is the heart of the Amundsen-Scott South Pole Station.

Current theories hold that neutrinos come from the interiors of pulsars, black holes, and other celestial objects that act like immense particle accelerators that copiously produce high-energy neutrinos which can penetrate the densest materials without being absorbed. The AMANDA detector may provide some of the first experimental evidence that black holes are the engines that drive quasars, some of the brightest and most distant objects in the universe. To date, there is very little experimental evidence for many cosmological models. Detecting these neutrinos can provide us with some of the first factual information.

The AMANDA detector will actually look through the earth, gazing into the northern sky, using the planet itself to screen out all of the unwanted cosmic rays that cascade through the upper atmosphere and into the shallow depths of the ice below. AMANDA works by looking for the muon "signatures" created by these elusive neutrinos when, on very rare occasions, they collide with the atoms in the ice.

The fact that neutrinos go through everything in the universe necessarily makes them very difficult to detect, but when you stop a neutrino in water or ice, it makes a muon particle which gives off Cerenkov light. This faint blue Cerenkov light exists for about three-billionths of a second, but sensitive phototubes at the heart of the AMANDA detector are capable of detecting these fast signals and determining where in the sky the neutrino that created the muon came from with no more than a one-degree error.

The detection process can be likened to detecting a boat traveling through the water by detecting and measuring the bow-wave it creates. The muon or boat traveling through ice or water creates Cerenkov light or a bow-wave which is detected by light detectors or the motion of buoys in the water. By noting the times when the detectors or buoys were hit, the direction of the wave front can be reconstructed, and from that information, the direction of the muon or boat can be determined, as shown in the figure below.



Detecting Neutrino In the Ice

During the 1991-92 season at South Pole, physicists from UW-Madison, UCB, and UCI, and drillers from PICO, began the process of coring deep into the Antarctic ice in preparation for the deployment of AMANDA's first two detector arrays. The PICO team, lead by Bruce Koci, hot-water drilled two 20-inch-diameter holes to depths of 2800 feet, and physicists then lowered arrays of photosensitive detectors into these boreholes that were subsequently

(continued on page 13)

HUNTING NEUTRINO PULSARS USING THE SOUTH POLE ICE CAP

(continued from page 12)

allowed to freeze in. This first ice-bound neutrino detector prototype was turned on January 5, 1992, while the instrument was immersed in water surrounded by -55°C ice at a depth of 2800 feet, and it was monitored throughout the freeze-in process to verify its survival. As of March 1992, it was successful.

Future plans call for deployment of the full-sized array. AMANDA will consist of strings of 20 photomultiplier tubes, each embedded in the Antarctic ice cap at a depth of more than half a mile where the ice is sterile and so clear that you can see 60 feet or more. If these preliminary tests are successful, AMANDA could grow to accommodate hundreds of sensor-laden strings that would, in effect, transform a cubic kilometer of the Antarctic ice sheet into a huge neutrino telescope, possibly allowing the discovery of things we have never even dreamed of. The presently envisioned detector allows us to study neutrino masses and search for "dark matter." This dark matter, or "the missing-mass needed to close the universe," is one of the holy grails of physics today.

Funding for this project was provided by the National Science Foundation, the University of Wisconsin (UW), UCB, UCI, the UW Graduate School, and the UW Hilldale Foundation.

Editor's Note: Dr. Morse is a Professor in the Physics Department, University of Wisconsin-Madison. Dr. Morse also serves as Principal Investigator of the AMANDA project.

PICO LOGISTICS AIDS NATIONAL SCIENTIFIC BALLOON FACILITY RESEARCH

PICO Logistics supported research projects in Greenland for the National Scientific Balloon Facility (NSBF) in early 1992.

The NSBF is operated for the National Aeronautics and Space Administration by the Physical Science Laboratory, New Mexico State University, Las Cruces, New Mexico. The facility located at Palestine, Texas, provides complete balloon operations services and engineering support to U.S. and foreign communities.

Types of research for which balloons are used include cosmic ray studies; gamma and x-ray astronomy; optical, UV, and infrared astronomy; atmospheric sciences; magnetospherics; and micrometeorite particles.

CONFERENCE ANNOUNCEMENTS

The Ice Core Working Group (ICWG) plans to meet July 14, 1994, at the University Club in Boulder, Colorado. The West Antarctic Ice Sheet Steering Committee meeting is planned for July 15 at the same location. Contact Dr. Jim White (303/492-5494 or whitejw@CUBLDR.Colorado.EDU).

The primary objectives of the ICWG meeting are to:

- identify major scientific questions
- prioritize deep and shallow drilling projects
- address funding problems
- discuss the future role of the ICWG

PERMAFROST TEMPERATURE OBSERVATORIES

The U.S. Army Cold Regions Research and Engineering Laboratory (USA/CRREL) in Hanover, New Hampshire, has been tasked to establish permafrost borehole temperature observatories at several field sites in Alaska. The permafrost of the world (20% of the land area) contains in its present thermal regime a history of climate change that has occurred over past centuries. Large-scale climate change can be recovered by careful monitoring and analyzing deep borehole temperatures. A site near Fairbanks (Bonanza Creek) and two on the North Slope have been selected for drilling and coring. PICO arranged for drilling and logistics services in association with Dr. Thomas Osterkamp of the Geophysical Institute, University of Alaska Fairbanks, for Dr. Virgil Lunardini of the USA/CRREL.

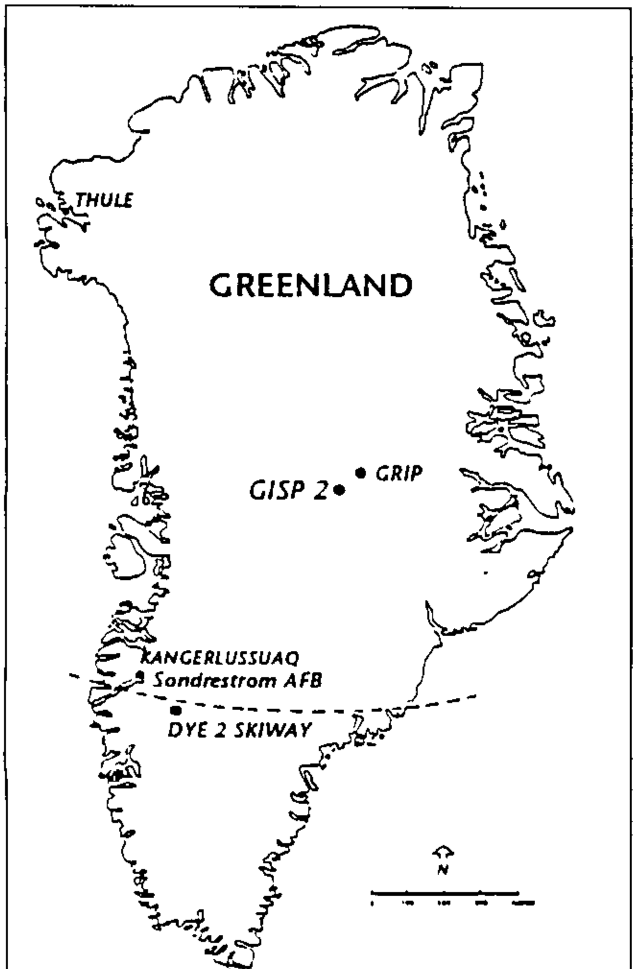
NORTHERN TERRESTRIAL RESEARCH DIRECTORY

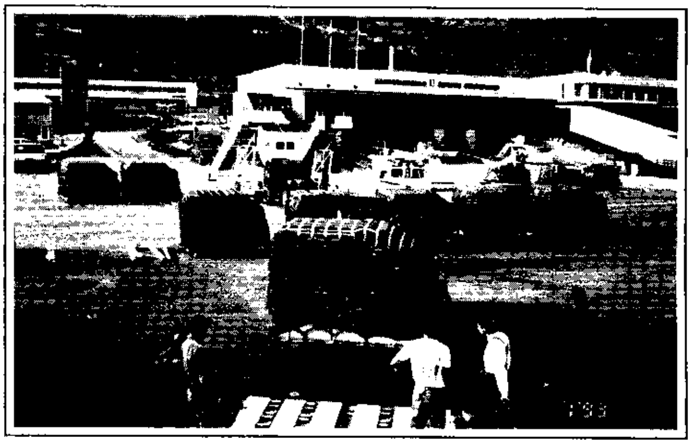
A directory of northern terrestrial research sites, including stations, biosphere reserves, and other protected areas, was compiled by C. Slaughter, J. Brown, W.P. Adams, K. Phillip, and A-L. Sippola. The directory was published in the October 14, 1993, issue of the Northern Sciences Network Newsletter (No. 14). A more complete data base will be available later in 1994. Revisions to this data base will be maintained at the Northern Sciences Network office located in the Danish Polar Center (Dr. Henning Thing, Strangade 100H, 1401 Copenhagen, K, Denmark. Fax: 45-32-88-01-01).

NEW QUARTERS AT KANGERLUSSUAQ FOR PICO LOGISTICS

On April 1, 1993, PICO Logistics opened the Greenland Field Center (GFC) for operations in Kangerlussuaq, Greenland. This is a full-service center providing communications, berthing, maintenance areas, and heated cargo staging areas. The GFC serves as the center for logistics support in Greenland of all NSF-sponsored research activities. The GFC is staffed with a Field Operations Manager and assistant, providing support for all needs of transit personnel such as meals, lodging, and cargo transport. Sam Lamont oversaw services as the Field Operations Manager for PICO in Greenland.

Mr. Erik Sorensen, Airport Manager, made it possible for PICO to make an efficient transition from its former quarters to its current offices in what used to be the USAF firehouse near the airport runway. This move occurred during the last season in support of the GISP2 project. PICO will continue to use these facilities in support of post-GISP2 projects in Greenland.





Ice retrograde operations at the Kangerlussuaq airport facility. (Photo by Sam Lamont)

SONDRESTROM AIR FORCE BASE TRANSFERS TO GREENLAND HOME RULE GOVERNMENT

The U.S. Air Force in Sondrestrom completed its three-year withdrawal plan on 30 September 1992. The runway and military assets transferred to the Greenland Home Rule Government. An airport authority, Mittarfeqarfiit, has been established under the Ministry for Public Works and Housing to operate Greenland's airports and heliports. Sondrestrom Air Base combined with the civil airport under its Greenlandic name, Kangerlussuaq, and will continue to serve as the gateway to Greenland.

Airport management has been granted a considerable amount of flexibility in developing the airport's potential as a scientific, tourism, and conference center. The facilities and equipment which transferred to the Home Rule Government and the facilities on the north side of the runway present opportunities for Greenland. It is expected that there will be hundreds of rooms available for housing, conference and tourism use, and many other purposes. In addition, a large amount of heated and unheated storage space will be used to support several new missions.

One of the possible uses of these facilities is for a scientific center for use by all scientists and scientific support personnel in Greenland and surrounding areas of the Arctic. Consolidation of scientific quarters, offices, laboratories, conference rooms, and storage needs into a few well-maintained buildings should serve to reduce overall costs for the scientific community. A scientific center at Kangerlussuaq will serve the interests of both Greenland and the various organizations that conduct scientific activities there. The combination of good facilities, air and seaport access for resupply, proximity to the ice cap, and incomparable flying weather make Kangerlussuaq the ideal location for an arctic conference and science support center.

RESEARCH AND DEVELOPMENT

Dr. Nagornov, Dr. V.A. Morev, and Dr. V. Zagorodnov at PICO.

RUSSIAN SCIENTISTS COLLABORATE WITH PICO STAFF

Dr. Victor S. Zagorodnov, Senior Research Glaciologist at the Institute of Geography, Russian Academy of Sciences in Moscow, is a visiting research professor at the Institute of Marine Science, University of Alaska Fairbanks, and collaborates with PICO on several developmental ice coring and ice analysis systems.

Zagorodnov's field of expertise is ice core drilling, ice core analysis, and the hydrothermal regime and structure of glaciers. During the period 1972-1991, Dr. Zagorodnov carried out field and laboratory studies on stratigraphy, structure, and the hydrothermal regime of temperate and polar glaciers. He has designed a portable Ice Core Analytical System, directional drilling equipment, and a new Antifreeze Thermo-electric Drill. Dr. Zagorodnov and his family have lived in Fairbanks since 1991.

Dr. Valentin A. Morev, Head of the Ice Engineering and Thermodrilling Laboratory, Arctic and Antarctic Research Institute at St. Petersburg, was invited to PICO to provide drilling equipment for a cooperative experimental study of ice core stability using an ethanol-water solution.

Dr. Morev took part in four Antarctic and nine Arctic expeditions. He invented an antifreeze thermal drill which has been used for drilling of deep boreholes in the Arctic and Antarctic ice caps.

Dr. Oleg V. Nagornov, Associate Professor at the Moscow Engineering Physics Institute, has been invited to PICO to carry out joint research on ice core stability and thermodynamic properties of an antifreeze liquid in a borehole by mathematical modeling.

The joint scientific research program with PICO includes theoretical and experimental investigations of thermoelastic stresses in ice cores and stability of ethanol-water solution in boreholes. The study of these phenomena will make it possible to improve the quality of cores and method of drilling. An important aspect of this collaborative research is to improve coring methods to achieve the least impact to the environment. A major contribution from this collaboration is a monograph entitled *Thermal Drilling of Glaciers* by V. Zagorodnov, O. Nagornov, J. Kelley, and V. Lunardini, with a publication target date in 1995.

SWEDISH GRADUATE STUDENTS ASSIST PICO

PICO assisted with a Master of Science degree project for two Swedish students: Bengt Wikman and Hans Vallgren. The two mechanical engineering graduates from Luleå University in Sweden arrived in Fairbanks on July 24, 1993, and stayed through November. They gathered research and test data on the use of small turbo-charged diesel engines as power plants for use in high-altitude, low-temperature remote locations. PICO provided the use of two turbo-charged diesel generators as well as a computer, work area, and tools for the students' project use. The results of this research will aid PICO in its support of high-altitude, small-party expeditions.

Wikman and Vallgren produced a PICO Technical Report entitled "A Study of Turbocharged Diesel Engine Performance for Intermediate Altitudes and Cold Climate Operations" (TR-93-7). This is the second occasion that PICO collaborated with the UAF School of Engineering and Luleå University.

RESEARCH AND DEVELOPMENT PROGRAM

by Kerry Stanford, Technical Services Manager, PICO

The process of drilling and coring ice and snow requires a wide variety of tools to fit a particular application. Parameters such as ice temperature, borehole depth, drill-site location, and quality of the ice sample recovered, all play a part in the selection of the right drill for the job. Logistics requirements are also a determining factor, particularly with respect to equipment weight, fuel usage, drilling rate, and required drill crew size. All of these things must be considered for their application to the special requirements of a project and to make full use of any applicable innovative technology which is available.

Numerical analysis techniques have provided needed drill recovery data and knowledge of freeze-in pressures seen by downhole instrumentation. Innovative approaches to ice coring have been tested in the form of a hot-water mechanical drill and an antifreeze electrothermal coring system. Research on drilling fluids resulted in the selection and use of environmentally benign products.

Based on the obvious needs listed above, PICO/UAF has encouraged research and development in the area of specialized equipment for ice drilling and coring. Past efforts have included research into low-horsepower diamond core drilling, which resulted in the rock drill add-on to the 13.2-cm ice-coring drill. Those involved in the conceptual development of the design and drilling procedure included Karl Bergman, Jesse Collins, Terry Gacke, Dave Giles, Bruce Koci, Kerry Stanford, and Mark Wumkes--all of PICO--and Larry Kozycki of the Geophysical Institute machine shop. Design, specification, and test of the drill were carried out by Kerry Stanford and Jesse Collins. Detail design, documentation, and integration of the drill with the 13.2-cm drill system were done by Larry Kozycki. Parts were made by the Geophysical Institute machine shop, with a large portion of the fabrication done by Ned Manning. Operating parameter data were provided by Zhengwen Wang, a Ph.D. program graduate student, under the direction of Dr. Scott Huang, School of Mineral Engineering, and with assistance from Jesse Collins.

Special thanks go to the Longyear Company and to Christensen Mining Products for their equipment, data, and assistance in the project. Success could not have been achieved without the interest and aid generously provided by both of these firms.

IMPROVEMENT OF THE PICO ELECTROMECHANICAL ICE-CORING DRILL

by Jesse Collins, Field Engineer, PICO

Field tests of the improved PICO 4-inch electromechanical ice-coring drill were undertaken on the Greenland ice cap and on the Guliya Glacier, China.

Major improvements of the 4-inch system include the incorporation of a planetary gear speed reducer in the motor section reducing vibration inherent in the previous speed reducer. A rigid connection between the outer core barrel and motor section prevents the oscillation of the top of the core barrel, thus reducing core breakage. Wider flights on the stainless steel inner core barrel were incorporated to improve chip transport and increase rigidity of the inner core barrel. The antitorque system has been improved by the use of machined aluminum sliders with provisions for improved spring adjustment. Instrumentation to indicate cable tension and depth has been added. The mechanical emergency brake on the winch has been replaced with a hydraulically actuated brake.

ICE MODELING SERVICES

Dr. Fucheng Li, a Research Associate working with PICO since April 1991, is from northeast China. For several years before coming to the University of Alaska Fairbanks in 1987, he conducted research on the mechanical and physical properties of sea ice at the Sea Ice Center, Dalian, China. In 1991, after studying the dynamics of sea ice and ice islands in the Arctic Ocean by computer modeling under Professor Sackinger of the Geophysical Institute, he received his Ph.D. in geophysics.

With PICO Dr. Li studied glacier ice problems in and around an ice borehole. These studies involved deformation, heat exchange, and phase change by computer modeling. During the fall and winter of 1993-94, Dr. Li participated in the AMANDA project in Antarctica and in an ice dynamics project in the Arctic Ocean.

A VALUE-ADDED LOGISTICS INFORMATION SYSTEM IS DEVELOPED AT PICO

by Scott Jackson, Logistics Manager, and Shawn Abshear, System Administrator, PICO

A chronic problem affecting the provision of logistics services in remote regions is information. We used a PICO logistics requirements model to identify unique logistic issues related to remote field scientific support needs. A Value-Added Logistics Information System (VALIS) was developed in collaboration with private industry.

Phase I of VALIS has been completed and is fully operational. This year, during the Greenland and Alaska field seasons, information will be transmitted to and from all appropriate remote sites via satellite through VALIS to ensure that all site support needs are maintained. VALIS enables administrative and field personnel to accomplish their tasks more effectively. UAF/PICO is currently utilizing the following system components of VALIS:

- Purchasing
- Cargo Information
- Passenger Information
- Personnel Information
- Inventory Management
- Medical Information
- Electronic Rolodex
- Permitting Management

Phase II will incorporate the development of an Arctic Information Center (AIC). AIC will be accessible to users worldwide, providing information primarily for support of the science community.

Phase III will involve the development and implementation of an Expert System. This system will incorporate an Artificial Intelligence Language in which users will ask specific questions and receive specific answers to address science-support issues.

Dr. John Kelley introduced VALIS at the December 1992 meeting of the Arctic Research Commission, where it was endorsed with enthusiasm. Since that time, VALIS has continued to be improved and developed by the UAF/PICO team.

The PICO Bulletin is published by the University of Alaska Fairbanks

Editor: **John Kelley**

Contributing Editors: **Jeanne Wollman**
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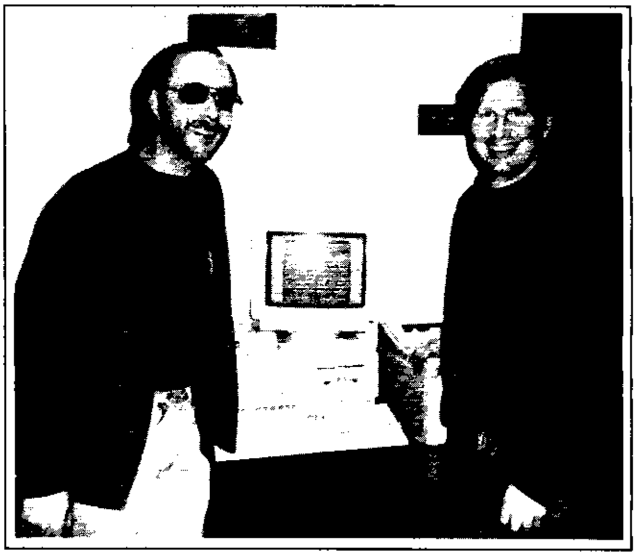


Shawn Abshear (left) and Scott Jackson.

JOINT RESEARCH BETWEEN MECHANICAL ENGINEERING DEPARTMENT AND PICO

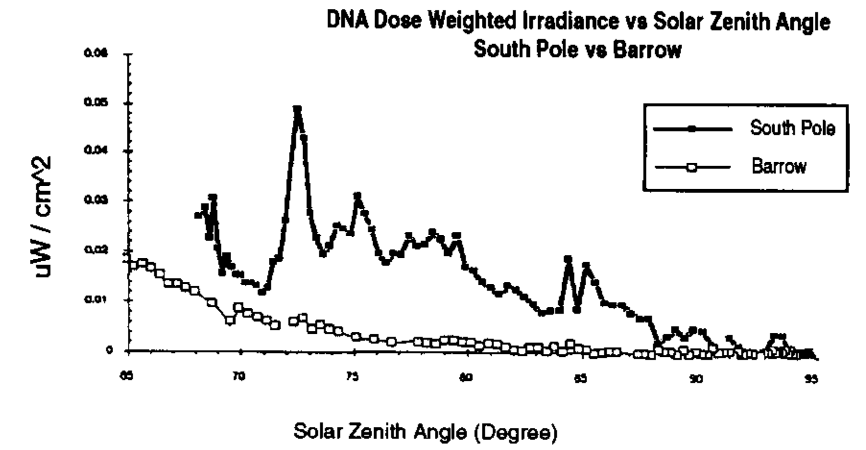
by Deben Das

In 1990, Dr. Deben Das, Professor of Mechanical Engineering at the UAF School of Engineering, began to direct graduate research toward PICO engineering needs. This research involved thermal modeling of ice cores, new concepts of coring drills, and freezing of boreholes. Upon completion of the initial modeling study, a thermo-mechanical drill design evolved in consultation with Bruce Koci, PICO's Senior Engineer, that could use hot water or an environmentally acceptable drilling fluid. A prototype drill was built by Eric Johansen at the School of Engineering's machine shop. This drill was subsequently tested successfully in recovering ice cores at the PICO ice test well in Fairbanks.

Two graduate students in mechanical engineering directed their thesis research to this project. This collaborative research resulted in two master's degree theses in mechanical engineering, two papers in refereed journals, one paper in a monograph, one paper in an international conference proceedings, four published abstracts, six technical presentations, and two PICO technical reports. Additional journal publications from theses are contemplated.

Editor's Note: Other collaborative projects in the School of Engineering have been with faculty and students of the Departments of Civil, Environmental, and Electrical Engineering, and Engineering Management.

UV RADIATION MONITORING AT BARROW, ALASKA



Source: Biospherical Instruments, San Diego, CA

The establishment of a monitoring network for ultraviolet (UV) radiation has been a critical part of the U.S. Antarctic Program. Its purpose is to evaluate the consequences of stratospheric ozone depletion on the health and productivity of organisms and personnel in polar regions. This monitoring network provides independent confirmation of the role of the ozone layer in moderating UV solar irradiance. Biospherical Instruments Inc. (San Diego, CA), under the direction of the National Science Foundation, is responsible for its operation and the distribution of data to the scientific community.

The project started in late 1987 with the installation of high-resolution-scanning UV spectroradiometers at the South Pole, McMurdo, and Palmer Station in Antarctica and in Ushuaia, Argentina. In December 1990, a system was added to the network at Barrow, at the northern tip of Alaska. This installation is housed in the Ukpeagvik Inupiat Corporation, National Arctic Research Laboratory (UIC-NARL), under a lease administered by PICO until July 1993, and normal operations are conducted by Dr. David Norton and his students at the Arctic Sivunmun Ilisagvik College. Calibrations and occasional servicing are conducted by Dan Anders and Chris Churylo at the National Oceanographic and Atmospheric Administration's Geophysical Monitoring for Climatic Change installation, also in Barrow.

The primary purpose of the establishment of the NSF spectroradiometer network is to provide high-quality measurements of UV irradiance to help assess the impact of the ozone depletion. While data from the Barrow installation has not revealed high levels of ozone depletion (yet), it is interesting to contrast data from the South Pole with Barrow during the last year. Since the latitude of Barrow and the South Pole are different, we have chosen to present data as a function of the altitude of the sun at noon, as seen from sunrise in the spring until the summer solstice.

The accompanying figure shows this trend. The UV spectra are weighted by a function determined to show the various wavelengths of light according to their ability to cause damage to DNA in organisms. The great increases at the South Pole in this damaging irradiance, associated with ozone depletion, is dramatic.

Source: Biospherical Instruments Inc., San Diego, California.

NEWS FROM ABROAD

JAPANESE ICE-CORING CONFERENCE

Ice Drilling Technology, the Proceedings of the Fourth International Workshop on Ice Drilling Technology, April 1993, was recently published in the series *Memoirs of the National Institute of Polar Research, Special Issue 49*, Tokyo, Japan. The proceedings (ISBN 0386-0744, March 1994) were edited by Professor Okitsugu Watanabe of the National Institute of Polar Research (NIPR). Send inquiries to NIPR Publications (Fax: 03-3962-2225).

DEEP ICE CORE DRILLING AT DOME FUJI

The Dome Fuji Deep Ice-Coring Project is the third phase of a comprehensive Antarctic glaciological program done by the Japanese Antarctic Research Expedition (JARE). The project consists of two main scientific activities: (1) glaciological research from the coast to the dome summit and (2) deep ice core drilling at Dome Fuji.

Scientific emphasis will be placed on (1) studies related to the dynamic state of the ice sheet and its changes, (2) ice sheet environment, and (3) paleoclimate reconstruction. The site for the deep drilling is located at the summit of Dome Fuji at 77°22'S, 39°37'E and 3810 m a.s.l. Drilling will be carried out in 1995 and 1996 by the 36th and 37th JARE wintering teams.

NEW INTERNATIONAL RESEARCH CENTERS

The Danish National Research Foundation has recently established three new research centers.

The International Research Center for Computational Hydrodynamics (ICCH) under the direction of Dr. Per Madsen will undertake research leading to new and improved models applying to a number of oceanographic and engineering areas.

The Centre for Remote Sensing at the Institute of Electromagnetics at the Danish Technical University will continue to develop a synthetic Aperture radar and concentrate on practical applications such as charting and growth of sea ice and detection of sea pollution. The center is under the direction of Dr. S.N. Madsen.

The Centre for Lithosphere Research at the Geological Survey of Greenland, The Geological Institute and Geological Museum at the University of Copenhagen, will concentrate on studies in Greenland. Greenland contains rocks which describe the lithosphere throughout almost four billion years. State geologist Hans Christian Larsen has been appointed leader of the center.

Editor's Note: Communication from Dr. Jorgen Taagholt, Danish Polar Center.

KANGERLUSSUAQ INTERNATIONAL SCIENCE SUPPORT FACILITY (KISS)

The Greenland Home Rule (GHR) Government established a new science support facility in order to stimulate and attract international research interest in arctic science.

The Kangerlussuaq International Science Support (KISS) facility lies at the head of the 140-km Kangerlussuaq fjord on the site of the former U.S. Sondrestrom Air Force Base, renamed Kangerlussuaq after transfer of the base to the GHR Government.

The close proximity of the Greenland ice sheet and the fjord to the KISS facility, as well as the facility's location within the low arctic ecozone, present unique logistic opportunities for studies on the ice sheet to the sea. Kangerlussuaq is also the main hub for air traffic within Greenland and abroad. KISS offers an array of modern facilities including lodging, lab, and conference space.

The KISS facility is operated year-round by the Kangerlussuaq Airport management. Initial contact for full details regarding use of the KISS facility should be addressed to the Danish Polar Center. (Telephone: 45-32-88-01-00; Fax: 45-32-88-01-01).

DANISH POLAR CENTER

In January 1993, the Danish Polar Center moved into two buildings that had been renovated for its activities. Located at Strandgade 100 H, DK-1401 Copenhagen, Denmark, the Danish Polar Center shares space with the Arctic Institute and the Department of Eskimology of Copenhagen University.

The two houses shown in the illustration below represent the center of polar research in Denmark. The drawing was prepared by Jens Rosing for a Greenlandic postage stamp celebrating the 200th anniversary of the Greenland Trade Department.

Source: Dr. Jorgen Taagholt, Danish Polar Center.

KTB PROGRAM, GERMANY

Professor Emmerman, Director of the Continental Deep Boring Program (KTB) of the Bundesrepublik announced that the KTB's deepest hole in 1994 will be 10 km. This hole will be the deepest in Germany. Scientists have taken core to the depth of 8312 m. Mr. Dorn, who is in charge of the Research and Information Office, said the intent was not to reach a record depth, but to core to a depth of 10 km in order to do research on processes taking place in the deep crust of the earth.

After the planned closure at the end of 1994, the program will be continued on an international level in the Oberpfalz, Bavaria.

Source: Windisheschenbach, AP: 9/23.

IN MEMORIAM

DR. WALTER ABBOTT WOOD

Dr. Walter Abbott Wood died on May 18, 1993, at the age of 85. He was a geographer and past president of the American Geographic Society and the Explorers Club. He was also active in the Arctic Institute of North America (AINA). He joined AINA in 1948, and in addition to serving as director of the New York office, he was a member of the Board of Governors for three decades and supported AINA activities in the mountainous Alaska-Yukon Boundary region from the end of World War II until his death.

Walter A. Wood received an honorary doctorate from the University of Alaska in 1955. He loved the North Country and contributed greatly to the scientific understanding of it, both through his own work and in his generous support of others. In 1988, Professor R.P. Sharp dedicated his book *Living Ice* "to Walter A. Wood and the memory of Foresta H. Wood and Valerie F. Wood, who so generously and joyfully introduced me to the world of living glaciers."

In 1961, Dr. Wood launched the ten-year-long Icefield Ranges Research Project (IRRP) which brought together more than 300 U.S. and Canadian researchers in joint, cooperative scientific exploration of the region along the Alaska-Yukon Boundary. He was responsible for establishing the AINA Kluane Lake Research Station which grew from his original IRRP base camp. More than 600 students from around the world have studied the northern ecosystem from the AINA Kluane Lake Research Station.

Source: Dr. Carl S. Benson, Professor of Geophysics, Emeritus, Geophysical Institute, University of Alaska Fairbanks.

MALCOLM MELLOR, D.Sc., Ph.D.

Dr. Malcolm Mellor, Editor-in-Chief of *Cold Regions Science and Technology* since its founding in 1978, died of heart failure in Hanover, New Hampshire, USA. He was employed by the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL).

Malcolm Mellor was born in Stalybridge, Cheshire, and resided in England until 1955 when, having obtained a B.Sc. degree in civil engineering from Nottingham University, he moved to Australia. He continued his education at Melbourne University, receiving a M.Sc. degree in meteorology and physics in 1959. He later received a Ph.D. in applied science from Melbourne University and another in engineering from Sheffield University in England.

At CRREL, Dr. Mellor's research and engineering investigations concentrated on the physical and mechanical properties of snow, ice, and frozen ground. His field work took him to Antarctica, Greenland, Alaska, Siberia, Labrador, Yukon, Korea, and the high mountains and cold regions of the contiguous United States.

Source: P. Sellmann and S. Bowen.

DR. WILLIAM J. CAMPBELL

Dr. William J. Campbell, world-renowned polar scientist, died November 20, 1992. He was a meteorologist with the U.S. Geological Survey (USGS) since 1963 and was chief of the Ice and Climate Project, a research group with the USGS based at the University of Puget Sound in Tacoma, Washington.

Dr. Campbell focused his studies on the Arctic and Antarctic ice masses through the development and application of satellite remote sensing techniques. He was a pioneer and leader in the field of microwave remote sensing of the cryosphere.

Source: Dr. Ed Joshberger, USGS, Tacoma, WA.

(Photo by Dave Giles)

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GRADUATE STUDENT RESEARCH DIRECTED TOWARD PICO ACTIVITIES

The location of PICO at the University of Alaska Fairbanks (UAF) attracted the interest of graduate students especially during the development of the deep ice-coring drill. The following theses represent the work of graduate students who directed their research to answering technical questions of interest to PICO:

A Study of the Effect of n-Butyl Acetate on a Motor and Gear Reducer System for a Deep Ice-Coring Drill by Å. Hagberg and T. Henriksson, Luleå University, Sweden, in cooperation with the School of Engineering, UAF (M.S., Mechanical Engineering, 1990). Faculty Supervisor: Dr. T. McFadden.

Finite Element Approach for Determining Temperature Variation in Ice Cores by S.S. Jois, School of Engineering, UAF (M.S., Mechanical Engineering, 1992). Major Professor: Dr. D. Das.

A Management Control System for Remote Regions Projects (An ILS Model Network, Logistics Information System, and Support Information Package for Use by the Polar Ice Coring Office) by S. Seetharaman, School of Engineering, UAF (M.S., Engineering Management, 1993). Major Professor: Dr. L. Bennett

Determination of Temperature Distribution During Ice Coring with a Composite Cylinder by S. Hazarika, School of Engineering, UAF (M.S., Mechanical Engineering, 1993). Major Professor. Dr. D. Das.

A Study of Turbocharged Diesel Engine Performance for Intermediate Altitudes and Cold Climate Operations by H.M. Vallgren and B.F. Wikman, Luleå University, Sweden, in cooperation with the School of Engineering, UAF (M.S., Mechanical Engineering, 1993). Faculty Supervisor: Dr. T. McFadden.

Rock Drilling Mechanism of Diamond Core Bits by Zhengwen Wang, School of Mineral Engineering, UAF (Ph.D., Geological Engineering, 1994). Major Professor: Dr. S. Huang.

Design and Testing of a Point Support Foundation System for Structures Placed in Snow by V. Mimken, School of Engineering, UAF (M.S., Mechanical Engineering, 1994). Major Professor: Dr. K. Curtis.

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	Dave Koester
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* Position funded by UAF.
** Position funded by NSF/OCE Alaska Native Student Intern Program (graduated, BSCE, 1994).

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