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Daybreak SCIENCE & MEDICINE

Ken Golden/University of Utah

A penguin poses for the camera as the National Science Foundation's icebreaking research ship, the Nathaniel Palmer, is docked in the distance during a trip to Antarctica to study polar sea ice.

THE MATHEMATICS OF ICE

Ken Golden/University of Utah

Researchers measure increase in ice thickness in Antarctica. Study is aimed at understanding polar ice and major role it plays in Earth's climate and weather.

U. Professor Goes South to Study Antarctica's 'Blanket'

By Lee Siegel
THE SALT LAKE TRIBUNE

The glittering beauty of light as it danced off snow and ice drew Ken Golden to mathematics, to Utah and to an Antarctic adventure amid fierce storms, 30-foot seas and frigid floes.

And delays during his latest trip to Earth's southernmost seas almost made him miss his own wedding.

Golden, an associate professor of mathematics at the University of Utah, is among 50 scientists nationwide working on a $10 million Navy effort to learn how microwaves reflect and scatter off polar sea ice.

As the project's theoretical research coordinator, his workis aimed at improving the accuracy of measurements when planes and satellites bounce microwaves off polar ice, then capture the reflected microwaves to learn what the ice is like: its age, thickness, roughness, brine content, porosity and so forth.

The project, which began in 1992, stemmed from the Navy's desire to help U.S. submarines navigate and communicate beneath the ice shelf. The findings still should help ships navigate around ice, said physicist Art Jordan, of the Naval Research Laboratory in Washington.

With the end of the Cold War, the research now is aimed at understanding polar ice and the major role it plays in Earth's climate and weather. The transfer of heat from oceans to the atmosphere drives the planet's weather, and sea ice serves as an insulating blanket that influences the process.

By determining the detailed internal structure of sea ice — a mixture of frozen water, brine and air — Golden also hopes to learn more about other "composite" materials: mixtures of substances that don't react chemically with each other.

The movement of sea water through porous ice is similar to the movement of electrons through certain semiconductors, the formation of cracks in metals and the weakening of human bone by the disease osteoporosis.

"Developing the mathematics for understanding sea ice will help us understand the fractures of metals in things like airplane wings and buildings, and will help us understand the development of osteoporosis in bones," Golden said.

Using microwaves to study sea-ice characteristics also is similar to making medical images of the body with

■ See ICE, C-2

Ice Is a Hot Topic To U. Professor

■ Continued from C-1

hopes his research will contribute to better ways of creating medical images for diagnosing disease.

Golden, 36, explained his $550,000 share of the five-year research project during an interview and at the U.'s quarterly science-at-breakfast lecture Wednesday at Little America Hotel.

"It all started with skiing, to tell you the truth," said the Salinas, Calif., native, who grew up in Maryland. "In sixth grade, I started skiing in Pennsylvania and I fell in love with the beauty of snow and ice."

Despite his love of recreation and partying, Golden admitted that "fundamentally, I am a geek."

So instead of vacationing during the final summer of his high-school years, he studied glaciers and ancient climate at Colorado's Institute for Arctic and Alpine Research. When school resumed, he spent two days a week at NASA's Goddard Space Flight Center, analyzing satellite photos of sea ice.

After enrolling at Dartmouth College in New Hampshire, Golden studied calculus and the theory of electromagnetic waves, which include visible light, microwaves, radio waves and X-rays.

Beautiful Math: "I was fascinated by the beauty of the mathematics behind light," Golden recalled. "That's what drew me into being an applied mathematician — a person who develops mathematical models of physical phenomena."

In 1991, it also helped lure him from Princeton University to Utah, where he loves skiing and "the beauty of the incredible snow on the mountains."

Now, from the ninth-floor Salt Lake City condominium he shares with his wife, Clarisse — an architecture student at the U. — Golden enjoys views of the Wasatch and Oquirrh ranges when he works at home.

Golden's job is to create complex mathematical theories and formulas for eventual use in computer programs. When microwaves are bounced off sea ice, Golden's formulas can be used to translate the reflected microwave data into meaningful information about the characteristics of the ice.

"Ken Golden and the other mathematical modelers are playing an important role in developing accurate and efficient computer programs to process the data, and from that to predict the detailed physical properties of sea ice," Jordan said.

Knowledge from the ice project also should help the Navy with other remote-sensing programs, such as using sound waves or microwaves to detect mines on the sea floor, Golden said.

But to know what reflected microwaves reveal about the ice, it first is necessary to bounce microwaves onto it from a ship while scientists walk onto the ice and directly measure its properties. That way, a variety of microwave patterns can be correlated with corresponding characteristics of the ice.

So Golden developed his formulas, then went to Antarctica to test them. He left Salt Lake on June 24 for Punta Arenas near Chile's southern tip, where he boarded the National Science Foundation's icebreaking research ship, the Nathaniel Palmer, which also carried scientists working on other projects.

> ***"It's the experience of a lifetime. It's like being on another planet."***
>
> KEN GOLDEN
> Mathematician and ice researcher

It was winter in the Southern Hemisphere, and the vessel crossed some of the world's stormiest seas en route to Antarctica's Weddell Sea and pack ice.

Rough Seas: "We hit 30-foot seas, very high winds, rain and ice," said Golden, who enjoyed swaying back and forth in the ship's bridge as huge waves broke over the decks.

"He was the only one who didn't puke," his wife said.

An engine breakdown forced the ship back to Chile for repairs and threatened to delay Golden's trip, which might have made him miss his Sept. 10 wedding.

After consulting with his bride-to-be via a satellite electronic-mail hookup, Golden took the risk and again boarded the Palmer for its voyage to the ice.

"She realized how important it was to me," said Golden, who nevertheless worried that if he missed his wedding, "I'd be killed."

The ship ran short of fuel and returned earlier than planned, so Golden got home Aug. 25 in time to save his impending marriage.

The summer adventure was Golden's second trip to Antarctica, which he visited aboard the icebreaker Polar Sea in 1980 during his senior year at Dartmouth.

This trip, the Palmer plowed through ice up to 7 feet thick. It stopped two or three hours every 50 miles so Golden and colleagues could disembark. Amid penguins, seals and occasional killer whales, they measured the ice pack's thickness, temperature, brine content, internal structure and other properties.

A horn on the Palmer's bridge bounced microwaves off the ice and collected the returning signals.

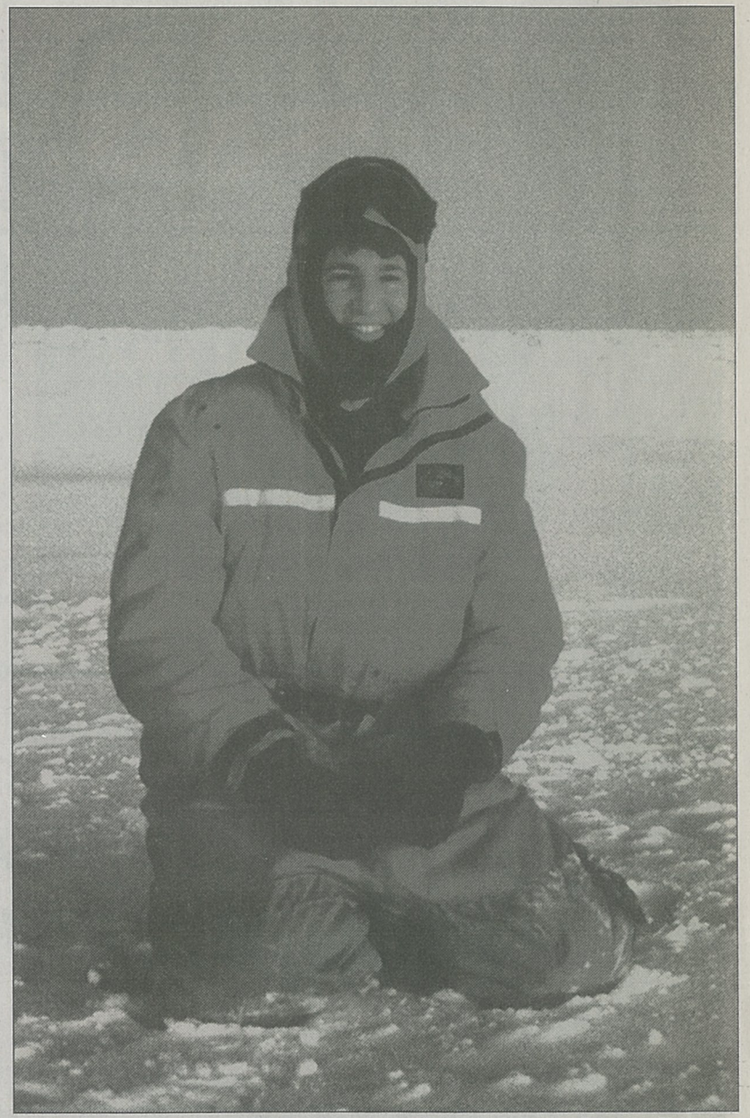
The ship also made two longer stops to allow researchers to set up floating camps on the ice to perform more detailed experiments. They erected six of seven portable huts and unloaded snowmobiles and millions of dollars of scientific equipment.

While scientists ate dinner on the Palmer one evening, the ice started cracking during a raging storm. The weather calmed by morning, and the crew managed to retrieve almost all the equipment, although one instrument and a small computer sank into the icy sea.

During the trip's round-the-clock research schedule, Golden worked 9 p.m. to 4 a.m. under the ship's floodlights and often got little sleep.

But he didn't mind storms with 90-mph gusts or the bone-chilling cold: about 22 degrees below zero Fahrenheit, not counting wind chill.

"It was so cool," he said. "It's the experience of a lifetime. It's like being on another planet, being in the midst of incredible ice formations. . . . You're just out in this vast, white expanse. It's beautiful. It made me want to stay there. It made me want to go back, which I hope to do."



Naomi Darling/Princeton University

University of Utah professor Ken Golden braved fierce storms and frigid floes to study Antarctica's chilly "blanket."