



OCEAN explorer

For the Young Associates of

Woods Hole Oceanographic Institution VOL. 2, NO. 2 DECEMBER, 1992



Antarctica as seen in a composite photograph taken by satellites. The Transantarctic Mountains spanning the continent form one of the world's longest mountain chains. The mountains divide the continent into Lesser Antarctica and Greater Antarctica.

NASA PHOTO

THE FROZEN CONTINENT

ONE OF ANTARCTICA'S nicknames is "The Ice," and for good reason; 98% of the continent is permanently covered by a sheet of ice, with an average thickness of 2,155 m (about 7,000 ft). In some spots the ice scrapes the ocean floor below and towers into the sky above as high as 4,500 m (15,000 ft). That's as tall as 12 Empire State Buildings placed one on top of another. Antarctica is the home base for 90% of the planet's ice and 68% of its fresh water.

At 8,640,000 sq km (5,400,000 sq

mi), about the size of the United States and Mexico combined) Antarctica is the world's fifth largest continent. It is also the coldest, driest, highest, and windiest continent on earth, with winter temperatures that can dip down to -88°C (-127°F) and winds that may gust up to 320 km/hr (200 mph).

Although the Antarctic Ocean is filled with abundant life, the continent itself is almost lifeless, except in the 2% of it that is ice-free in the summertime. There is less annual precipitation in Antarctica than in

the Sahara Desert in Africa. The climate in some parts of Antarctica has been compared to that of Mars.

Antarctica is also the world's only international continent, thanks to a treaty signed in 1961. It is the only continent on Earth devoted purely to scientific research. Still relatively pristine, it is also the one nearly wild continent on earth.

Journey with *Ocean Explorer* to the Seventh Continent. You'll learn what it's like to live and work there, and you'll meet some of the creatures that call Antarctica home.



Biologist Dale Goehring, who first became interested in science when she visited Woods Hole Oceanographic Institution as a child.

DO YOU HAVE THE RIGHT STUFF?

What It's Like to Live and Work in Antarctica

THE JOB HAS NEVER BEEN advertised in a newspaper, but if it were, the ad might read:

WANTED: RESEARCH ASSISTANT IN ANTARCTICA

Can you live for seventy days without a television, bathroom, or telephone? Can you focus—truly focus—on something without thinking about whether you're tired, hungry or dirty? Can you live where the wind drones continuously at 24 km/hr (15 mph)? Can you stand for fourteen hours? Do you have an unusually high tolerance for very cold weather? Can you get a good night's sleep when the sun is shining? If the answer to all of these questions is yes, you might have the right stuff to join Woods Hole Oceanographic Institution's next journey to Lake Fryxell in Antarctica.

Joining this team, which has travelled to Antarctica for several months in each of the last five years, is clearly not for everybody. But there are those who swear there's nowhere else on earth they would rather be—at least during the austral summer, which runs from August through February. Then, the sun shines in the sky twenty-four hours each day.

"Being in Antarctica is such an extreme experience that I can close my eyes and imagine I'm there, even when I'm right here in my office," says Research Assistant Dale Goehring, leaning back in her desk chair. "The scenery is very intense, striking—the blue glaciers, the big, white mountains—it looks totally unlike anything else. Even the sun sits in a different position in the sky. It sits just above the horizon and moves around us in a circle."

"The air is so clean, so clear," adds Associate Scientist Brian Howes, the WHOI biologist who is the expedi-

tion leader, "you can see for many, many miles." Sound travels quite far there, too. "You can hear the sound of a 'helo' from miles away."

HELLO, HELO

"Helo" (pronounced *HEE-lo*), is Antarctica slang for "helicopter." Helos are the lifelines for those who live on the ice. The helos that service Brian and Dale's camp are operated by the United States Navy. They travel almost 96 km (60 mi) from the nearest civilization, McMurdo Base, which has 1,200 summer inhabitants and is the largest U.S. settlement in Antarctica, to the WHOI base at Lake Fryxell, a 7 sq. km (2.5 sq. mi) body of water, permanently covered by 3m (16 ft) of ice.

Helos bring mail, food, news, and most important, fresh faces. "It's like living in a frontier town in the old West," says Dale, "waiting for the stagecoach to come through."

MOTIVATION

What lures these and other researchers to this cruel, lonely land of ice, wind, and bitter cold? The attraction is the unparalleled opportunity to conduct research in one of the last relatively pristine environments on Earth. "Our basic goal for being there is to do research," says Brian. "We are not there for a wilderness experience."

Brian, Dale, and their team travel each year to Antarctica to study Lake Fryxell, a basin that is relatively untouched by human pollution, to better understand similar bodies of water in other places that are already polluted. They are trying to separate environmental (that is, naturally-occurring) from human-caused factors affecting these bodies of water. When they get enough information, they hope to be able to make good predictions about the

future of basins. "But it's very difficult," says Brian. "We've been working on this for ten years."

PREPARATION

How do you prepare for a trip of this scope, where *everything* necessary, from fuel to generators to chocolate bars, must be flown in at great expense? "You just worry about it," says Brian. It has taken Brian and Dale several years to figure out what to bring, and what to leave behind. For example, after the first year, flashlights were left at home. "It was pretty silly to bring flashlights to a place where the sun never sets," laughs Dale.

Most of the clothes worn in Antarctica are issued by the U.S. government, which has long experience with the unusual requirements of this "hardship post." There is government-issued long underwear (Dale recommends one suit for each week), wool shirts, pants, mittens, hats, face masks, and scarves, as well as down vests, heavy cotton wind pants, leather over-mittens, goggles, really warm boots, and most important, a down parka with a fur-



DALE GOEHRING/WHOI

Biologist Brian Howes, who traces his interest in science to growing up in a family that was full of scientists.

trimmed hood. Additionally, the team packs the best sunglasses they can find, since the extreme brightness of the perpetual sunlight against the snow can easily damage their eyes. And socks. Lots of socks. Since the researchers can't shower or bathe for the seventy days or more of their stay, being able to put on a clean pair of socks every so often is a necessary luxury. Most important of all, each member of the team is assigned their own "blankie," a soft, fleece blanket that is one of the few comforts of home.

The researchers pack huge quantities of food, too. To generate enough internal heat to keep their bodies warm, they have to eat twice as much as they would in a warmer climate. Because the climate is so dry, and because so much body moisture is lost just in breathing the cold Antarctic air, lots of fluids are necessary, too. "We always keep an eye on each other to make sure we're not getting dehydrated," says Dale. "It's pretty easy to forget to drink enough when you're busy working. But after a while, you learn your limits." One of the team's many mottos is: "Stupidity kills."

GETTING THERE

The team, usually about seven people, travels from Woods Hole to Antarctica in several stages. The first is flying commercially from the United States to Christchurch, New Zealand. From there, they transfer to a military transport plane that flies them 3840 km (2400 mi) across some of the most treacherous seas in the world, to McMurdo base. From there, the team travels by helo to their permanent camp, a series of wooden shacks that serve as laboratories and a long, canvas building they call the Jamesway, that is the group's gathering place.



DALE COHEN/WHOI

From time to time, members of the team leave Lake Fryxell to climb some of Antarctica's many mountains.

Each person on the expedition sleeps alone in an unheated three-person tent. Times together are spent out on the lake, in one of the makeshift labs, or relaxing or eating in the cheerful, heated Jamesway.

ZERO IMPACT

The research team is extremely sensitive to findings that conclude that past scientific and exploration missions to Antarctica have left behind a shameful legacy of pollution. They know that the success of their research and that of all the other scientists who work in Antarctica depends on the continent's staying as close to pristine as possible. So theirs is a "zero impact" camp. Everything that is brought in, *everything*, including human body waste, is brought back out. "We didn't even spit on the ice," says Mike Bryson, a former Summer Student Fellow at WHOI who travelled with the team during the 1991 season.

ON THE JOB

Sixteen-hour work days are common at Lake Fryxell. The group drills holes in the ice, using motorized augurs that are shaped like giant corkscrews. When a hole has been drilled, they take samples of the water, and whatever is in it. The life they find is primitive, to say the least, mainly phytoplankton, just beneath the ice, and bacteria, farther down near the oozy muck on the bottom. "If this lake were a harbor," says Brain, "people would say it was polluted. But here in this environment, there is virtually no pollution. What we find is natural."

"It's like studying a marine system before the advent of fish," says Dale. She adds that Antarctica's cold desert climate has been compared to that of Mars. In fact, their work has been studied as an analog to future possible Martian research projects.

BEING THERE

There is one day each season when the team takes a break to clear their heads. On that day, they play in a horseshoes tournament against a group of helo pilots.

But first, last, and always, comes the work. The twenty-four hours of sunlight each day appeals to Dale and Brian, who are self-confessed workaholics. "We never have enough time down here," says Brian. "We have to work every possible minute."

"When it comes to what we do, there's no place I would rather be," says Dale. "Every other project just pales by comparison."

Right now, Brian and Dale and their team are in Antarctica, completing another research season. As soon as they return to Woods Hole, they'll start planning their next trip.

THE WORLD OF

ANTARCTICA

"THE NATIVES"

NO HUMAN BEING HAS EVER been born in Antarctica. But countless numbers of other living creatures have been. Most Antarctic natives live on the 2% of land that is ice-free for at least part of the year, or else in the Antarctic Ocean, which is one of the most productive marine ecosystems in the world.

Why is there so much life in this ocean? Perhaps because of the very strong water currents that swirl constantly around the continent, bringing a continual supply of dissolved minerals from glacier melts and from the ocean depths to the surface. These minerals, plus the 24-hours of sunlight per day (during the austral summer) send photosynthetic plants into production overtime, producing enormous blooms of phytoplankton and diatoms, the microscopic "grass" of the ocean. Phytoplankton in turn feeds krill, tiny shrimp-like creatures whose population swells to the billions in Antarctic waters after phytoplankton blooms. During these blooms, there is so much krill in the Antarctic Ocean that the water sometimes appears pink. Krill is in turn eaten by animals of many different sizes, from tiny Adélie penguins to blue whales, the largest animals on earth.

In all, the waters off Antarctica feed 35 species of penguins and other birds, 6 kinds of seals, 12 kinds of whales and more than 200 types of fish. Of all those creatures, five species of whale, four species of penguin, as well as many other types of birds, three species of seal and at least twenty species of fish rely on a diet of krill.

"THE VISITORS"

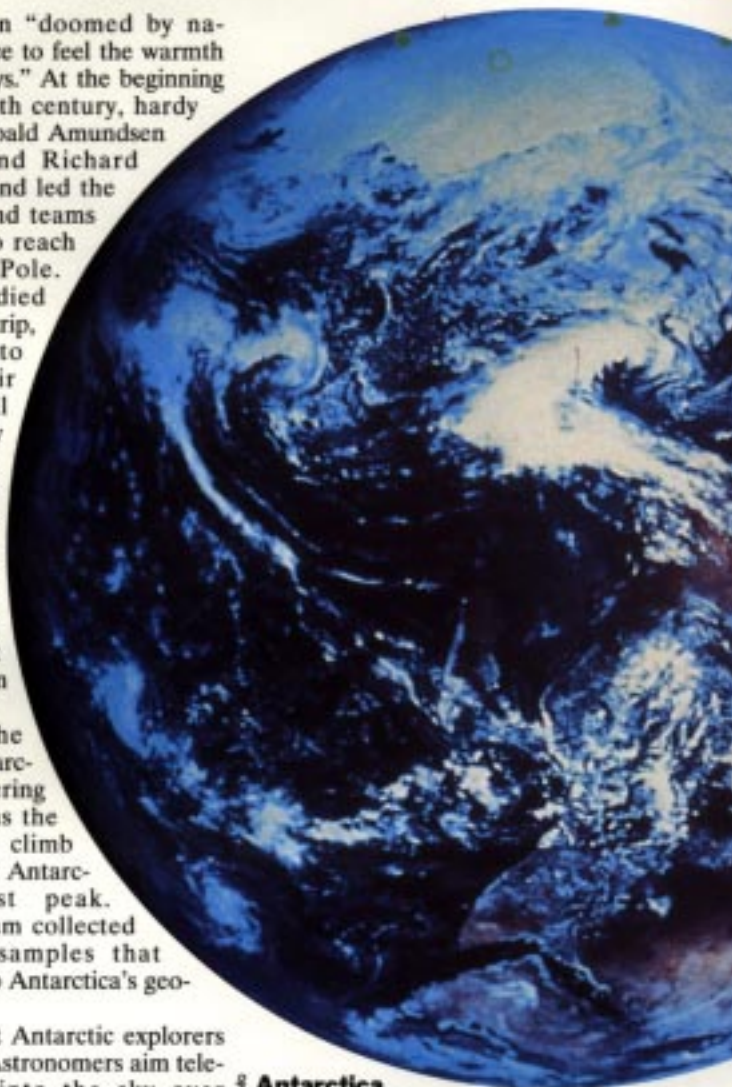
FOR MORE THAN TWO HUNDRED years, explorers have ventured to the bottom of the earth, curious about Antarctica, and willing to meet the challenges of its climate. Captain James Cook led the first voyages that crossed the Antarctic Circle in the late 1700s, proclaim-

ing the region "doomed by nature...never once to feel the warmth of the sun's rays." At the beginning of the twentieth century, hardy adventurers Roald Amundsen of Norway and Richard Scott of England led the first and second teams respectively to reach the South Pole. Scott's party died on the return trip, yet managed to leave as their legacy fossil samples they collected, which provided the first clues that Antarctica's climate may once have been a lot warmer than it is today—even tropical.

In 1966, the American Antarctic Mountaineering Expedition was the first group to climb Vinson Massif, Antarctica's highest peak. There, the team collected more fossil samples that offered clues to Antarctica's geologic past.

Today, most Antarctic explorers are scientists. Astronomers aim telescopes high into the sky over Antarctica, for they have discovered that the continent is an excellent platform from which to view far distant galaxies. Climatologists study Antarctic weather patterns as they try to better understand the climate of the entire world. Glaciologists drill into Antarctic ice sheets, studying core samples that may be millions of years old. Paleontologists are trying to understand the history of life in Antarctica.

Maybe someday you will become an Antarctic explorer, helping to find answers to questions scientists are just beginning to form today.



Antarctica, as seen from the space shuttle.

"...doomed by nature never to feel the warmth of the sun's rays."

—Captain Cook



Enlarged photo of marine diatoms, among the smallest components of the Antarctic food web. Each diatom is about as wide as a human hair.



Enlarged photo of krill. This krill is actually about as big as a fingernail.



NSF PHOTO



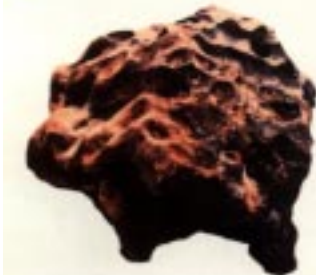
A Weddell seal turns its face to the summer sun.

Penguins at home on the rocky Antarctic terrain.

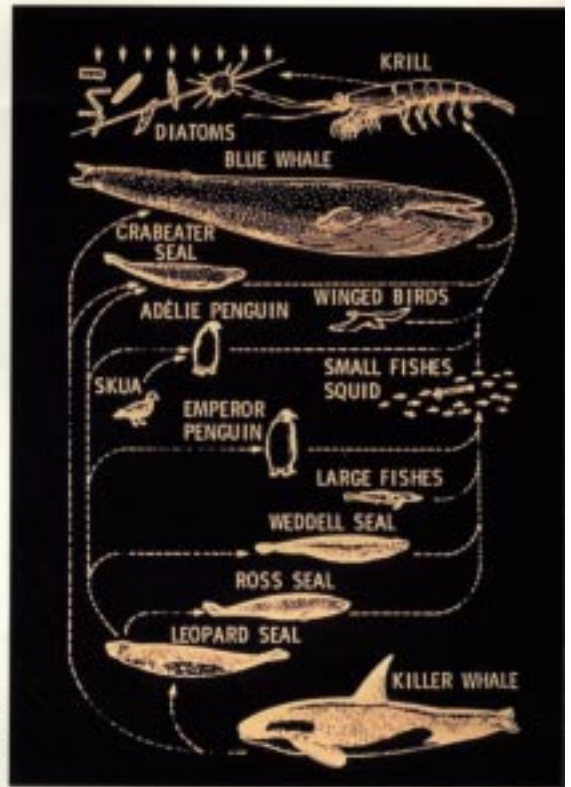


NSF PHOTO

Inside Captain Richard Scott's cabin, uninhabited for more than eighty years. Thanks to the dry, cold Antarctic climate, the cabin's interior appears eerily to be frozen in time.



Geologists who study meteorites find many samples in Antarctica's undisturbed terrain. A team of French and English geologists believe they have found meteorites in Antarctica that originated on Mars.



NSF DIAGRAM

The Antarctic Ocean Food Chain, showing the dependence of many species on krill.



NSF PHOTO

A pod of Orca whales on a seal hunt.

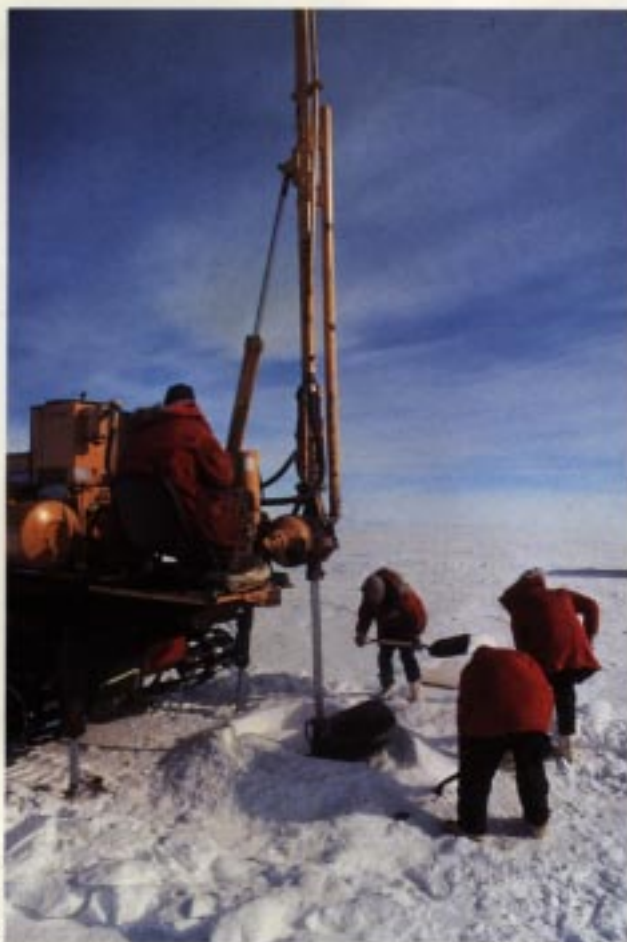
Climatologists float giant helium balloons over Antarctica to study a hole in the ozone layer that has been detected over the continent. The ozone layer protects the earth's surface from the effects of the sun's ultraviolet (UV) radiation. Scientists wonder how this will affect life in the Antarctic Ocean. Unfiltered UV radiation may already be killing great quantities of krill and phytoplankton.



NSF PHOTO

UNDER THE ICE

Scientists Scuba Dive in Near-Freezing Antarctic Water



RON OLIVER

Drilling through Antarctica's ice cap requires special tools. Here, scientists operate a huge auger capable of drilling holes that are about 1 m wide (3 ft).

Popping up from under the ice is Greg Dietzmann, Rich's dive partner and fellow scientist. After about forty minutes in Antarctic waters, he's ready to get out.



RICH HARBISON/WHOI

ISTUDY JELLYFISH," SAYS WHOI SENIOR SCIENTIST Richard Harbison, as he begins to explain why he enjoys scuba diving in the -2°C (35°F) water that swirls beneath the Antarctic ice cover. "I'm interested in comparing the jelly animals that live in the Arctic with those that live in the Antarctic." Over the years, Rich has found many species of jelly animals that only exist in polar waters, and nowhere in between. "I think these creatures might be a carryover from the last ice age," says Rich, when the overall oceans were a bit colder and animals could move between the poles in the deep sea.

"Antarctica is basically a big refrigerator with a lot of land underneath it," says Rich. "The water there is as cold as it can get before you have to walk on it."

Each dive Rich takes in Antarctic water is, by necessity, short. "I try not to stay in the water much longer than half an hour," he says. "I don't find it particularly awful, but my wife does." Rich's wife, Judy, has dived with him in both the Arctic and Antarctic, and, while she thinks that it's beautiful, it's just too uncomfortable for her.

Rich doesn't have to dive very far beneath the Antarctic ice cover to find the creatures he's looking for—perhaps as little as 30 m (99 ft). "We can't go as far down as we might usually go in warmer water," he says. "Our physiology gets screwed up because it's incredibly cold."

Why on earth does he do this? Because he gets to see so many kinds of creatures when he gets there. "There are incredible numbers of jelly animals."

When Rich prepares to dive under the Antarctic ice sheet, he can't just slip off a ship's deck and dive underwater. He and his fellow researchers have to drill

through the ice. They make two adjacent holes that are each three feet in diameter—one for each diver. For safety's sake, no one ever dives alone in polar waters.

Over the diving location there is a hut heated by a kerosene stove. If Rich goes diving through one of those huts, he puts on his dry suit (protective clothing that insulates all of his body, except his face, from the temperature of the water), heats the stove up, stays in the hut until he is really warm, and then hops into the hole in the ice.

Just getting through the ice cover can be a test of nerve. "It's sort of like going down a long tube," he says. "It's so spooky to go through that hole. I feel like I'm dropping out of the world."

Rich always dives with a partner. Nonetheless, it's a very eerie experience to dive beneath a ceiling of ice, with the only escape back to the surface two distant holes that are about half as big across as he is tall. Rich stresses the importance of the lifeline that runs from his drysuit to those who wait for him above the ice. "If I got separated from my lifeline, I'd never get back out." Fierce, unexpected currents spring up to remind Rich all too often of his lifeline's importance.

Though Rich has dived often in the open ocean, there is nothing to compare with diving in polar waters, particularly the waters off Antarctica. Beneath the ice cover, the visibility is incredible, especially during the austral spring, when there are virtually no phytoplankton (microscopic plants), whose presence in water tends to make it appear cloudy. "The water there is like air," says Rich. "It's the closest thing to floating in space I've ever experienced. You can go down 90 feet and look back up at the hole you came down through. You'll be able to see its edges, completely sharp, as though you were right next to it. It's like floating around in a big room filled with air."

Rich has so far discovered some interesting physiological differences between jellies in the Arctic and Antarctic. For one thing, Arctic

creatures are able to store food and fats over relatively long periods of time, whereas Antarctic creatures are more like creatures in the deep sea that don't know where their next meal will come from. Antarctic creatures are able to live for long periods of time on very little food. When food is readily available, they can take in a great amount at once.

Rich is always careful about where he dives and for how long. He knows at least one fellow diver who almost met his limit. He jumped in the water before his partner was ready to join him, so he ended up spending almost 50 minutes beneath the ice cap. Recalls Rich, "I took his temperature when he got out of the water. It was 93." The man was quickly warmed up, and resolved that in the future he would wait until his partner was ready before beginning a dive.

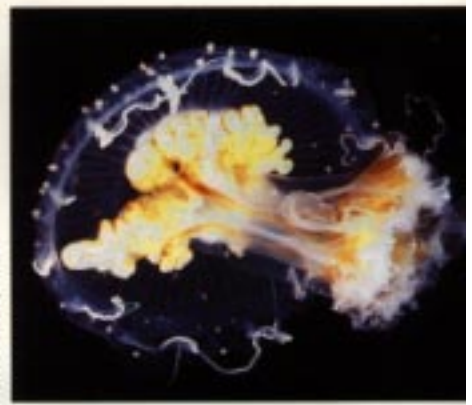
"It's like floating in a big room filled with air."

Even a dive that lasts for a relatively short amount of time leaves the diver feeling a little strange. "You don't feel bad," says Rich. "But you do feel kind of sleepy and dopey."

Those who help the diver out of the water at that point take responsibility to make sure he or she warms up.

Rich loves his work, and feels the risks are very worth the result. "I always wanted to be a marine biologist," he says. "Parents of one of my childhood friends recently showed me a picture I had drawn of myself when I was ten years old. I drew myself as a marine biologist." Rich studied biochemistry in college and graduate school. "Then I went on my first research cruise at sea," he says. "It was much, much better than staying in a lab all day. It was really fun."

Diving soon became a necessity. "Jelly animals can really only be studied by going underwater. They can't be collected with nets. They're too delicate." So Rich began jumping off ships and studying the animals in their native environment, trying not to disturb them. In spite of occasional discomfort, Rich loves his work. He says, "It's sort of like studying gorillas in Africa, only it's a lot harder, because you can only spend short periods of time under water."



RICH HARRISON/WIKI

***Diplumaris antarctica*, one of the creatures Rich travels to Antarctica to study.**



RICH HARRISON/WIKI

In the hut, Greg Dietzmann gets ready to dive (above). Antarctic divers often see penguins hunting for fish (below).



GREG DIETZMANN/WIKI

DOWN TO THE SEA IN JASON



QUEST GROUP INC.

IN THE MARCH ISSUE OF *OCEAN Explorer* you'll travel to the Gulf of California with the JASON Project, an "electronic field trip" conducted by WHOI geologist Robert Ballard under the auspices of the JASON Foundation for Education, which was established to show students the excitement of scientific exploration. Bob has led three JASON Project expeditions, where, via satellite hookup, hun-

dreds of thousands of students have watched scientists at work at remote sites around the world. In the fourth JASON Project, both the Remotely Operated Vehicle JASON and the submersible vehicle TURTLE will explore hydrothermal vents, create underwater maps, study jellyfish and perform experiments.

See you down there—way, way down there.

OCEAN EXPLORER

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