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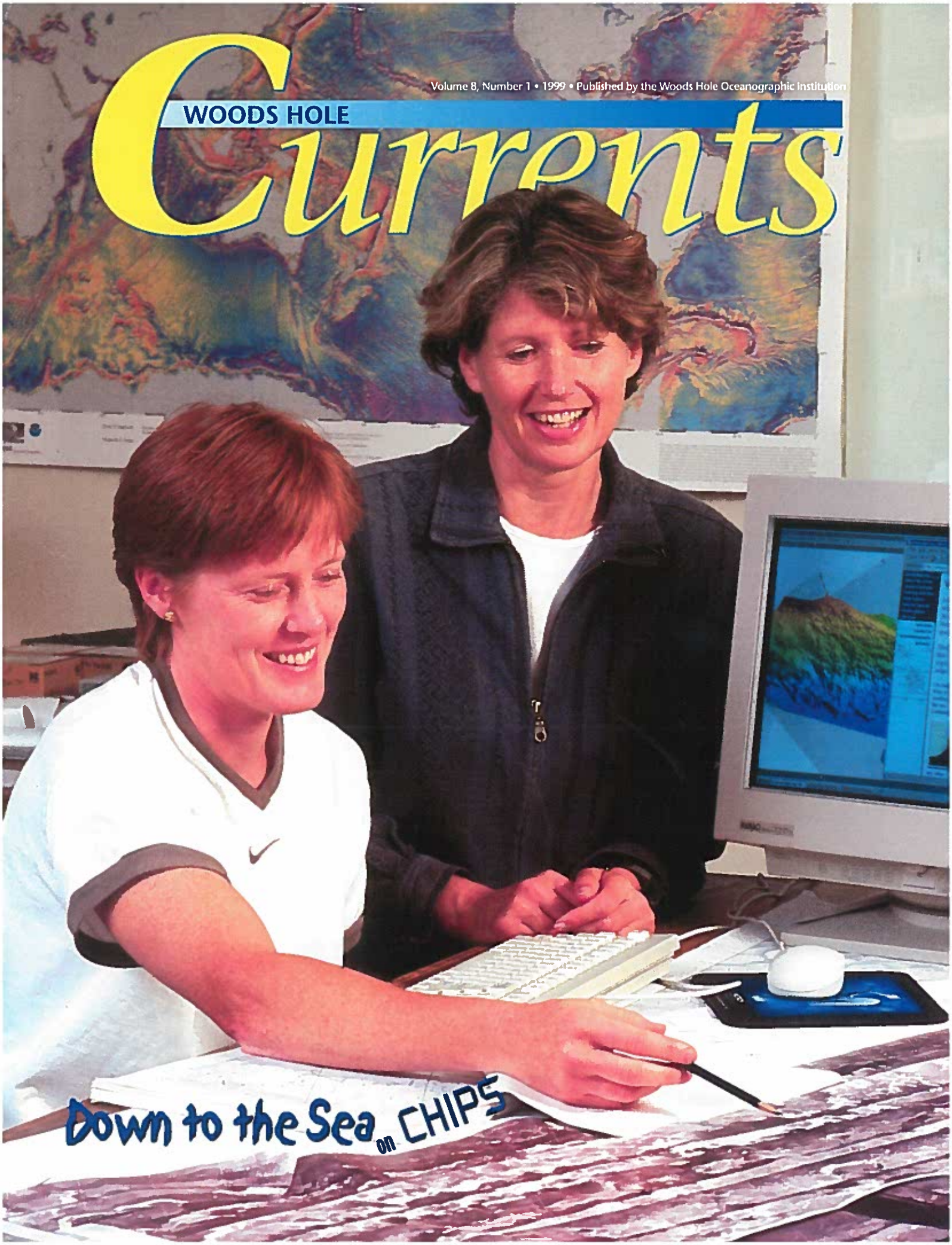
WOODS HOLE Currents



Down to the Sea on CHIPS

WOODS HOLE Currents
Volume 8, Number 1 • 1999

USGS/Hawaiian Volcano Observatory

Rivers of lava flow from Hawaii's Kilauea volcano. Just offshore, underwater eruptions created Puna Ridge—the target of a WHOI-led research cruise chronicled on an Internet site.

Dana Yoerger

An electrical & telephone 'outlet' for the seafloor.

Tom Kleindinst

Britain's Deputy Prime Minister visits WHOI.

On the cover:
Voyage to Puna Ridge: Associate Scientist Deborah Smith (right) and Research Assistant Lori Dolby created a Web site to share the day-by-day activities of an ongoing seagoing expedition with a wide audience.
Photo by Tom Kleindinst

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New Study Signals Dangerous Trend for Right Whale

Chris Slay, New England Aquarium

A new population dynamics study led by WHOI Senior Scientist Hal Caswell (photo above right) has warned that the current population of 300 northern right whales is not rising, as previously believed, but declining (graph below).

Declining Population Could Lead to Extinction

It was a wake-up call that the sun may be setting on the northern right whale. A new population dynamics study on the endangered whale reverses the prevailing belief that the species was making a slow comeback after being hunted almost to oblivion. Instead, the study showed that the current population of only 300 northern right whales was dropping by 2.5 percent per year—a trend that would lead to extinction in less than two centuries.

"Until this study no one suspected that the survival probability for northern right whales was going down or that the population was actually declining," said WHOI Senior Scientist Hal Caswell, who conducted the study with Solange Brault of the University of Massachusetts and Masami Fujiwara, a graduate student in the MIT/WHOI Joint Program. "Unless something changes, the whales are headed for extinction," he said.

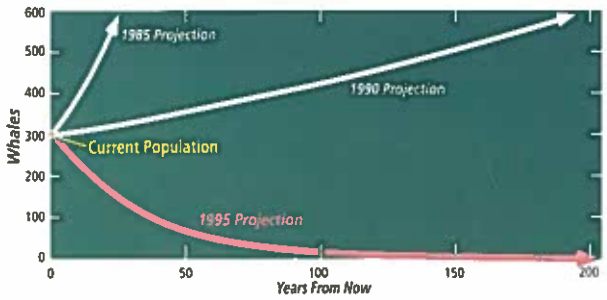
Because the whales tend to hug the coastlines and conveniently floated when killed, they became the "right" whales to target and were nearly wiped out by commercial whaling. Hunting was banned in 1935, but the species has not rebounded.

Caswell is a mathematical ecologist who has developed widely used modeling techniques to study population dynamics of species ranging from microscopic crustaceans called copepods to sea turtles and terrestrial plants. Tracking so few whales in a big ocean posed new challenges for the analytical methods, but the study offered potentially important new information to evaluate strategies to save the whales. The study was funded by the National Marine Fisheries Service and WHOI's Rinehart Coastal Research Center.

To begin to understand the species' numbers, movements, and behavior, the New England Aquarium launched an ambitious program in 1980 to photograph right whales so that researchers could identify and track individuals by unique head markings or distinctive scars.

Caswell and colleagues realized that the data set had built up long enough to give them a chance to detect population trends with their state-of-the-art statistical methods. Their results were dramatic and sobering: Survival had declined so far that instead of increasing, as was previously believed, the population was estimated to be declining by 2.5 percent a year.

Many right whales are killed in collisions with ships or by getting tangled in fishing gear (see related story, page 16). "Our results, while discouraging, are not hopeless if management efforts continue and are successful," Caswell said. Those efforts include recently launched programs to teach ship operators to recognize and avoid right whales and to alert them that they are entering whale habitats. Officials have closed fishing grounds during periods when whales are migrating through them. New state and federal regulations encourage development of whale-friendly gear and restrict fishing gear that poses risks to whales.



Jayne Doucette

Down to the Sea on CHIPS

A virtual voyage of discovery

This is for anyone who has ever had a burning desire to go on a voyage of discovery, but doesn't have a Ph.D. in science, can't afford to take off a month, gets seasick easily, or is too young to drive. Here's a chance to take part in a research cruise off the coast of Hawaii without stepping onto a ship or even getting near a shoreline. You *will* have to do a little surfing, however—Web surfing, that is.

WHOI Associate Scientist Debbie Smith has participated in more than a dozen research cruises—each one an exciting opportunity to learn something new, with a cast of interesting people in an interesting locale. Smith wanted to open a portal onto a world that the general public rarely gets to see. She wanted to capture the day-by-day activities of an ongoing seagoing expedition and to share them with the widest possible audience.

www.punaridge.org

The medium for the message was the Internet. She applied for and won a geoscience education grant from the National Science Foundation to create a World Wide Web site that would chronicle her cruise last fall to the Puna Ridge—a 75-kilometer-long submerged ridge built out of lava erupting underwater. It is an extension of the same subterranean volcanic plumbing system that created the active volcano Kilauea onshore.

The home page of the Puna Ridge Web site

If you haven't the foggiest notion of how oceanographic missions are planned, funded, organized, or conducted, if you can't begin to guess why Puna Ridge intrigues scientists, if you have no idea what transponders or lava terraces are, or how they work—boot up your computer, grab your mouse, and open this Web site: www.punaridge.org/. Step by step, click by click, screen by screen, you may find yourself gradually drawn into daily life aboard the research vessel *Thomas G. Thompson* off the big island of Hawaii. And you may well absorb a great deal of fascinating science along the way.

Smith, WHOI Research Assistant Lori Dolby, and Scott Garland, a programmer at Jungleware, Inc., designed the site in the typical riverlike structure of the Web. From the site's opening page, browsers can navigate downstream along several branches and tributaries. Some branches provide easy-to-understand briefings on

Edwin Schiele

WHOI Research Assistant Lori Dolby (left) and Associate Scientist Debbie Smith watch steam created as Pacific seawater quenches lava flowing from Hawaii's Kilauea volcano.

About the cruise: An Introduction

Kilauea erupts when magma (molten rock) rises from deep inside the earth and accumulates inside a reservoir approximately four kilometers underneath the summit. Sensitive instruments can actually detect the mountain swelling as pressure inside the reservoir builds. Eventually the pressure forces the magma to the surface and there is an eruption.

Although people usually think of lava spewing from the tops of volcanoes, many of Kilauea's eruptions, including the current one, have taken place along its flanks. Before an eruption on Kilauea's flanks, magma travels underground laterally (sideways) from the reservoir rather than straight up. These protrusions of magma extending from the reservoir are called dikes. Scientists theorize that as the magma pushes through the ground, pressure causes the surrounding rocks to crack. Magma rushes in to fill these cracks, and the dike becomes longer. When the magma reaches the surface, fissures open up, and lava pours out.

USGS/Hawaiian Volcano Observatory

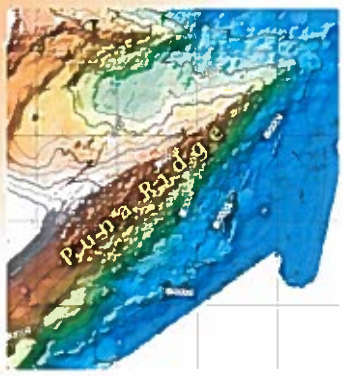
The system of cracks created by the underground movement of magma is called a rift zone. Kilauea has two major rift zones—the Southwest Rift Zone and the East Rift Zone. The East Rift Zone is by far the longer of the two and is currently the most active. It extends 55 kilometers from the summit to the shore then continues another 75 kilometers underwater.

Laura Kong

Kilauea is currently erupting from the Pu'u O'o vent on the East Rift Zone about 20 kilometers from the summit. The Pu'u O'o vent is shown in the picture on the left. Lava is spewing from the summit and moving away in a lava channel.

In the past, eruptions have occurred all along the rift zone, including the submarine portion. Puna Ridge is built from these underwater eruptions.

The primary goal of our cruise is to get a better understanding of the Puna Ridge. This information will help us to understand how magma moves within Kilauea volcano, where eruptions are likely to occur, and how the eruptions will act. It will also help us to understand the formation of other oceanic islands, submarine volcanoes and mid-ocean ridges.



the ship, the scientists and institutions involved, how the mission was planned and funded, and the scientific questions it was designed to explore. Another branch, called "Factoids," offers concise, relevant science lessons (using M&M candies!) on how sound and light are transmitted through water, how volcanoes work, and how to navigate using seafloor maps, for example. Another explains—in lay language and with useful diagrams—the workings of all the technological tools used in the mission, including WHOI's *DSL 120* sidescan sonar system, its *Argo II* photographic vehicle, the Global Positioning Satellite (GPS) system, and those aforementioned transponders.

In cooperation with the Hawaii Department of Education, Laura Kong of the University of Hawaii also developed lessons for students studying online. Kong, a WHOI alumna, was co-principal investigator on the Puna Ridge cruise. Also as part of the NSF education grant, high school teachers joined the cruise, participating in scientific watchstanding, providing journal entries for the Web sites, and taking back some of their on-the-job experience to their classrooms.

During the cruise, Dolby produced a "Daily Flash" page that provided photos and commentary as the mission evolved. She transmitted it via cellular phone to Hawaii, then on to Garland, who put it on the Web a day after the events described occurred. The Daily Flashes hinged on dispatches from the field written by a freelance science writer, Edwin Schiele. Over 36 days, Schiele takes readers along as he observes the action and roams about the ship with the wide-eyed curiosity of someone who, like him, had never been on a research cruise before. It's like reading a small-town newspaper. He takes part in the scientific work and talks with scientists, technicians, students, crew members on the bridge, oilers in the engine room, cooks in the galley—all the while conveying the pace, excitement, tension, monotony, camaraderie, isolation, long hours, and hard work of a typical cruise. You feel the intensity involved in trying to collect as much good data as possible, under difficult conditions and time limits—as well as the exaggerated delight of getting a copy of *The Boston Globe* after a few weeks at sea.

Web surfers clearly followed the daily exploits. The site had some 236,000 hits (a "hit" is any connection to the site) during the cruise. By a more conservative

measure, a "visit" (a series of consecutive requests within a site, indicating that a user spent some time there), the site was also successful, recording about 10,000 visits during October 1998.

"It was a marvelous way to let lots and lots of people know what we are doing," said Elizabeth Rom, the NSF assistant program manager responsible for sponsoring the Web project. "I think the Web is an especially great way to reach kids. They're the ones exploring, and we hope this really attracts them. I think the Web site turned out well and will serve as a template for other NSF-funded cruises."

Rom said the NSF has provided supplemental funds to help convert the Puna Ridge Web site from a real-time event to an educational resource. Dolby and Smith are adding more audio and video obtained during the cruise onto the site, with plans for a CD-ROM package that can be sent or transmitted electronically to teachers.

"The idea now is to make the site a retrospective for teachers to continue to use," Rom said. "For each new class of students, the experience will still be new."

See for yourself. Even now, months after the cruise ended, the Daily Flashes still offer a refreshing immediacy—even if the smell of salt air doesn't transmit well through cyberspace.

Daily Flashes: Day 10
Cones and Craters

October 5, 1998.

Cones, craters, rivers of lava pouring from the top and streaming down. For most people, that is the essence of volcanism. So imagine our excitement when the sonar images revealed these very features on Puna Ridge.

Most of what we know about how cones and craters form comes from studying subaerial volcanoes (volcanoes on land). The sonar images are now providing evidence that these same processes may apply to submarine (underwater) volcanoes as well.

Let's look at how we think cones and craters like Pu'u O'o (the site of the current eruption) form. Magma rises from the mantle, pools underneath the summit of Kilauea, and creates a magma reservoir. As the pressure builds, some of the magma moves laterally along the rift zone. These lateral extensions of magma are called dikes. We think that these dikes reach all the way to the end of Puna Ridge.


USGS/Hawaiian Volcano Observatory

At different points along the rift zone, magma rises from the dike and erupts through the surface. If the eruption goes on long enough, layer after layer of lava builds around the eruption site. The result is the familiar cone.

Now think about what would happen if the supply of magma rising up into the cone stops. Now the inside of the cone is hollow. Without the support of the magma, the top of the cone collapses and forms a crater. It's as if you removed the filling from a pie. Without the filling to prop it up, the crust collapses.

The sonar images show what clearly appear to be numerous cones and craters that formed from past eruptions along the top of the ridge. The sonar images have also revealed other features that may be remnants of past eruptions. Lava pouring down the side of a volcano creates channels. Through a series of complex processes, the outermost layers of lava in these channels harden, creating a lava tube. The lava from the eruption flows through these lava tubes. These tubes can continue until the slope of the volcano suddenly flattens out. At that point, the tubes may break and lava pours out in all directions. This is called a secondary eruption.

As the lava spreads out, it creates a terrace or table. It may help to consider what happens were you to angle a hose toward your driveway when the temperature was well below zero. The water would spread out along the driveway and freeze into a thick layer of ice.

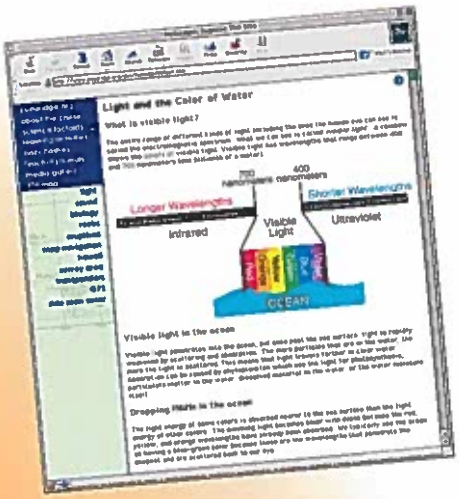
One idea is that lava bursts out from the base of the table and forms a new table right below it. This process repeats itself, creating a series of steps. As lava drains out from beneath the table, the top of the table collapses and forms a crater.

The sonar images show structures that may be lava channels. On the south side of the ridge, an area that the sonar has not reached, the bathymetric maps show possible lava tables and craters. Once we have finished the sonar mapping, we will send *Argo II* down to photograph these features and learn their true identities.

In fact, Debbie Smith wants to send *Argo II* inside the craters. It should be exciting!

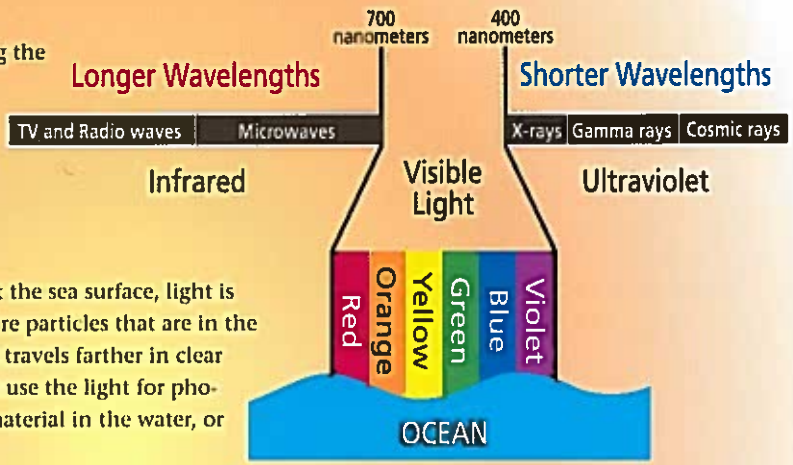
Science Factoids

Visible Light and the Color of Water



What is visible light?

The entire range of different kinds of light, including the ones the human eye can see, is called the electromagnetic spectrum. What we can see is called visible light. A rainbow shows the colors of visible light. Visible light has wavelengths that range between 400 and 700 nanometers (one billionth of a meter).



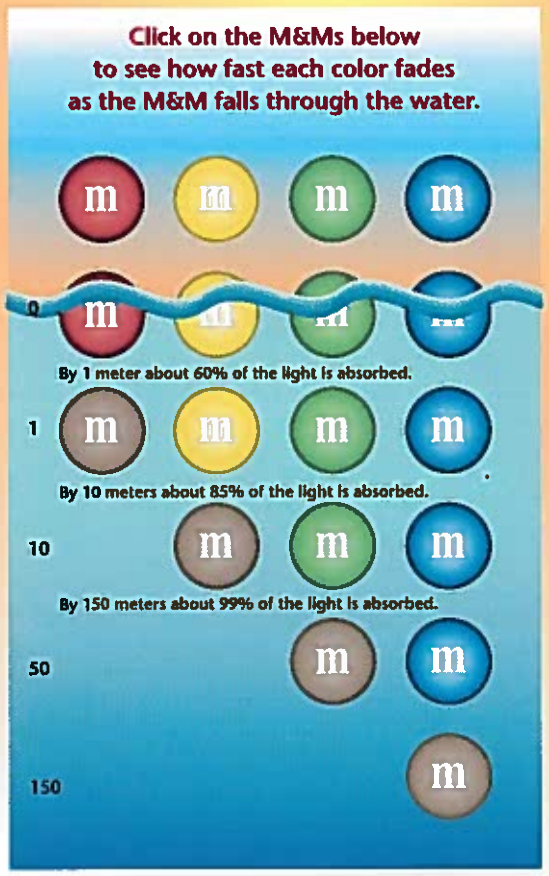
Visible light in the ocean

Visible light penetrates into the ocean, but once past the sea surface, light is rapidly weakened by scattering and absorption. The more particles that are in the water, the more the light scatters. This means that light travels farther in clear water. Absorption can be caused by phytoplankton that use the light for photosynthesis, particulate matter in the water, dissolved material in the water, or the water molecule itself.

Dropping M&Ms in the ocean

The light energy of some colors is absorbed nearer to the sea surface than the light energy of other colors. The dimming light becomes bluer with depth because the red, yellow, and orange wavelengths have already been absorbed. We typically see the ocean as having a blue-green color because these are the wavelengths that penetrate the deepest and are scattered back to our eye.

The upper 100–200 meters of the ocean is called the photic zone (photo=light). Beyond this depth, light does not penetrate, and it is pitch dark. All the production of food by photosynthetic marine plants occurs in this thin surface layer.



Dan Forsan

Test Your Understanding

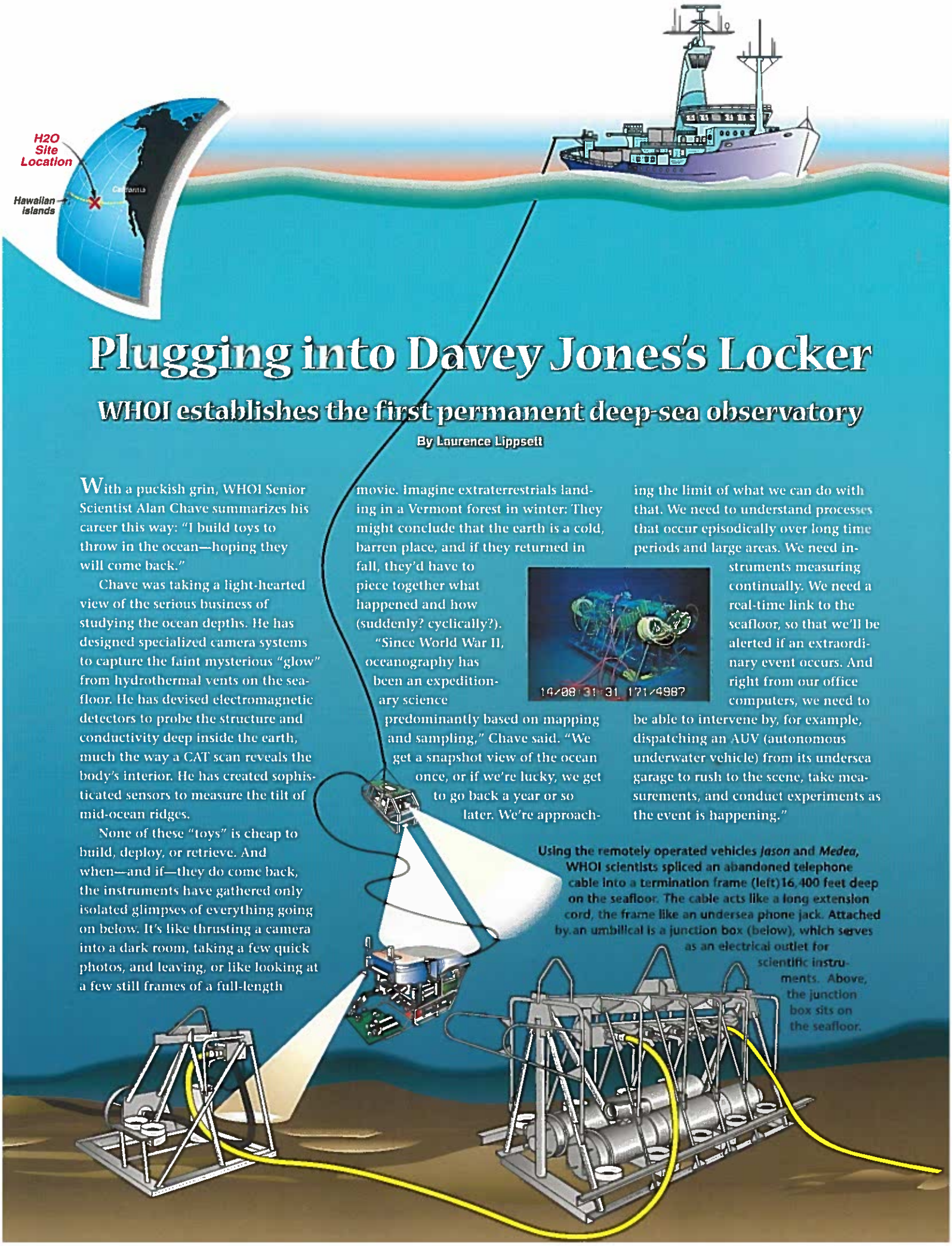
Why do tube worms living in water depths of 3,000 meters (9,000 feet) look red in photographs such as the one shown above?

Check your answer below to see if you are correct.

Red light penetrates to those depths.
○ No, remember the red M&M: Red light is absorbed very quickly.

A white light flash is used.
◉ Correct! White light contains all the visible colors.

A red light flash is used.
○ No, other colors in the photograph (yellow, white) would not be visible.



Plugging into Davey Jones's Locker

WHOI establishes the first permanent deep-sea observatory

By Laurence Lippsett

With a puckish grin, WHOI Senior Scientist Alan Chave summarizes his career this way: "I build toys to throw in the ocean—hoping they will come back."

Chave was taking a light-hearted view of the serious business of studying the ocean depths. He has designed specialized camera systems to capture the faint mysterious "glow" from hydrothermal vents on the seafloor. He has devised electromagnetic detectors to probe the structure and conductivity deep inside the earth, much the way a CAT scan reveals the body's interior. He has created sophisticated sensors to measure the tilt of mid-ocean ridges.

None of these "toys" is cheap to build, deploy, or retrieve. And when—and if—they do come back, the instruments have gathered only isolated glimpses of everything going on below. It's like thrusting a camera into a dark room, taking a few quick photos, and leaving, or like looking at a few still frames of a full-length movie. Imagine extraterrestrials landing in a Vermont forest in winter: They might conclude that the earth is a cold, barren place, and if they returned in fall, they'd have to piece together what happened and how (suddenly? cyclically?).

"Since World War II, oceanography has been an expeditionary science predominantly based on mapping and sampling," Chave said. "We get a snapshot view of the ocean once, or if we're lucky, we get to go back a year or so later. We're approaching the limit of what we can do with that. We need to understand processes that occur episodically over long time periods and large areas. We need instruments measuring continually. We need a real-time link to the seafloor, so that we'll be alerted if an extraordinary event occurs. And right from our office computers, we need to be able to intervene by, for example, dispatching an AUV (autonomous underwater vehicle) from its undersea garage to rush to the scene, take measurements, and conduct experiments as the event is happening."

Using the remotely operated vehicles *Jason* and *Medea*, WHOI scientists spliced an abandoned telephone cable into a termination frame (left) 16,400 feet deep on the seafloor. The cable acts like a long extension cord, the frame like an undersea phone jack. Attached by an umbilical is a junction box (below), which serves as an electrical outlet for scientific instruments. Above, the junction box sits on the seafloor.

The problem has always been power and real-time communications: No one has discovered any electrical outlets or telephone jacks on the seafloor. So Chave decided to try to install some. And to accomplish that dream economically, he wasn't above accepting someone else's castoff.

Three miles below the surface of the Pacific, a submarine telephone cable called HAW-2 (Hawaii-2) stretched across the seafloor. AT&T laid it in 1964 between San Luis Obispo, California, and Oahu, Hawaii, and for 25 years it did yeoman service, conveying up to 138 simultaneous trans-Pacific telephone calls. When the cable broke near California in 1989, AT&T decided it wouldn't pay to fix it and offered to donate it to the scientific community. There it was: a giant potential extension cord sitting on the seafloor 16,400 feet deep in the middle of the ocean.

Chave and colleagues at the University of Hawaii and the Incorporated Research Institutions for Seismology (IRIS) envisioned a way to convert HAW-2 into H2O, the Hawaii-2 Observatory—the world's first permanent deep-ocean observatory. Out of corrosion-resistant titanium, they would build a termination frame that would be spliced into the cable and serve as a combined undersea electrical outlet and phone jack, providing two-way electricity and communications between the bottom of the ocean and a station about 1,000 miles away at Makaha, Hawaii. Attached to this "T-frame" by a 90-foot electrical cable would be a junction box with eight specially designed underwater electrical connectors—sort of a "power strip" for undersea instruments.

Rhett Butler,IRIS

An 800-pound grapnel was used to snag and retrieve an abandoned trans-Pacific telephone cable from the seafloor.

Even though titanium prices had tripled (because of a surge in demand by golf club manufacturers, the largest consumer of titanium in the United States), the new observatory's $2.5 million price tag still seemed a bargain. It cost $30 million to lay the cable in 1964 and would cost $120 million to do so today.

The idea sounded great, but like virtually anything done in the ocean, executing it was far from easy. A lot of money and future science were riding on this pioneering mission, and a lot of people were watching to see if it could be pulled off.

Lawrence Carpenter

In a control room aboard ship, Will Sellers (center left) watches *Jason* on a video monitor and uses a joystick to controls its movements.

"It was the hardest thing I've ever attempted on a ship," Chave said, "and I wouldn't have tried anything like this without Beecher. He has 35 years of experience on the decks of UNOLS (University-National Oceanographic Laboratory System) ships."

"Beecher" is F. Beecher Wooding, and Chave exaggerated: At the time, Wooding actually had only 29 years' experience. As an undergraduate, he took a summer job at WHOI in 1961. He left in 1972 to go into the motorcycle business for a while, but returned in 1980 and now heads WHOI's Systems Technology Laboratory, which designs, builds, and uses mechanical systems for seagoing missions.

"I'm a nuts-and-bolts guy, and building gizmos and seeing if they work is every mechanic's dream," Wooding said.

"I've spent a fair amount of time at sea, and just as a result of kicking around, you get to know all the ships in the fleet, the crews, all the technicians, and you're better able to get things done because you have a better idea of what to expect," he said. "Nothing like H2O had ever been done from a UNOLS vessel in these water depths. We knew we would max out the capabilities of the equipment and people. We spent a lot of time planning in order to work out procedures that we thought would be effective."

So did WHOI's Deep Submergence Laboratory, whose remotely operated vehicle (ROV) *Jason* had a critical role—one that it had never played before. *Jason* repeatedly had shown its mettle exploring, surveying, and mapping on the seafloor—an eye in the deep. But for H2O, *Jason* had to have strong arms and

Lawrence Carpenter

Beecher Wooding (left) and Alan Chave prepare the junction box that will serve as outlet to plug in scientific instruments on the seafloor.

Jayne Doucette

nimble fingers, too. The DSL team was acutely aware that this would be the first time *Jason* would demonstrate its ability to be a workhorse that could install, service, and maintain a potential wave of future seafloor observatories, according to DSL team leader Andy Bowen.

"We were careful about planning and very attentive to testing and preparation," he said. The engineering team had fashioned new attachments for *Jason's* manipulator arm to cut the 1¼-inch coaxial cable and to plug it into the junction box. "We made a mockup of the junction box and put it off the WHOI pier and tested and trained and practiced before ever getting to the (H2O) site," Bowen said.

Dana Yoerger

Andy Bowen (top center) supervises the deployment of *Jason* over the side and into the Pacific.

Cutting a cable or plugging something in may seem easy, but not with a robotic arm controlled by a joystick connected to a fiber-optic cable dangling like a strand of spaghetti three miles beneath the ocean surface and attached to a vehicle hovering in moving currents.

"It took hundreds of hours of practice," said Will Sellers, *Jason's* chief pilot. He tested the new cutting device and practiced gripping the plug correctly and orienting *Jason's* "wrist" and "elbow" precisely enough to drive home the plug with the required 40 pounds of force. In the process, Sellers said he "did a bit of field engineering," using pipes and funnels to fabricate a guide that aligned *Jason* and the junction box in the perfect position to make the connection.

"It was a pretty challenging job," he said, his moustache camouflaging a hint of a smile. But that suited Sellers just fine. Here's a guy who joined WHOI in 1981 and has piloted *Alvin*, WHOI's deep-diving manned submersible, on more than 100 dives to the seafloor. He was the first to pilot *Alvin* to the wreck of *Titanic*. Nevertheless, in 1986, looking for a new challenge, he switched gears to pilot *Jason*.

Will Sellers is *Jason's* chief pilot.

In September of 1998 *Jason* was loaded aboard the University of Washington's R/V *Thomas Thompson*, and Chave, Wooding, Bowen, and Sellers set out with other scientists and ship's crew members to establish H2O.

The first hurdle was finding the cable, which was set on the seafloor in the days before the Global Positioning Satellite (GPS) system so accurately fixed ship positions. The team had chosen to locate H2O midway between California and Hawaii, 2,000 kilometers from the nearest island. The site plugged a vast gap in the global network of land-based seismometers, which monitors seismic waves generated by earthquakes and underground nuclear weapons tests. The recorded waves also help scientists learn about the earth's inaccessible interior structure. H2O greatly expanded the network's coverage and was particularly strategic because of its proximity to earthquake-prone California.

After a cable snapped and unexpectedly sent the termination frame plunging to the ocean bottom, scientists were relieved to find it sitting upright and ready to be plugged in.

It took *Jason* more than eight hours to locate the cable. It was about ¾ of a mile south of where it was supposed to be, lying between abyssal hills—a flat, tranquil stretch of seafloor that was perfect for a permanent observatory. Sellers directed *Jason* to follow the cable toward California for 5,000 meters (the water depth from ship to seafloor) and cut the cable at that point. Then an 800-pound grapnel was lowered from the ship to snag and retrieve the cable.

"We had to have equal lengths of cable—one water-depth—on each side of the grapnel, so that the cable wouldn't slide off," Wooding said—just the way you would pick up and balance a strand of spaghetti with a fork tine. But unlike a wisp of spaghetti, six miles of cable dragged through water put a load on the ship's wire and winch that approached their working weight limit of 24,000 pounds. It took nearly a day to lift the cable to the surface.

"We constantly stressed the mechanical capabilities of the ship," Wooding said. "We were on the edge of what the ship could handle."

"It was a delicate balance of not breaking the cable or the ship's equipment and not injuring anyone," Chave said. "Once the cable was onboard, we spliced the termination frame to the cable end, plugged in the junction box, and powered up the system from Hawaii. For the first time in nine years, HAW-2 was operational."

Over the next five days, the team

Lawrence Carpenter

Beecher Wooding (right) and John Hutchings of Margus Undersea Cable Systems cut the cable for splicing into the junction box.

tested the equipment, found bugs and ironed them out. They even made a call over the cable to Mike Purdy, director of the National Science Foundation's Ocean Sciences Division, which funded the project. Satisfied that the apparatus would work, the team began the process of lowering the T-frame and attached cable to the seafloor with a trawl line from the ship. It was barely over the side when a 1/2-inch chain securing the T-frame to the ship's line snapped. Lines lashed back furiously across the fantail. It was a stroke of good luck that no one was nearby and no one was injured. But in that same moment, the T-frame and the cable had plunged to the ocean bottom.

Lawrence Carpenter

Chave displays a section of cable.

"The chain should have been able to take a 40,000-pound strain, but it broke at 9,000 pounds," Wooding said. "It apparently was flawed but the pieces are lost in the ocean so we don't have the luxury of being able to examine them." The incident, he said, "was, and still is, a tremendous concern. It makes me nervous even now. When it broke, Alan and I were standing on deck, and we turned to each other and said, 'Well, that's it.' "

All that could be done was to assess the damage.

"We expected to find a rat's nest of cable over three or four acres," Sellers said. "For all we knew, there could have been loops of cable sticking hundreds of feet off the bottom, and then *Jason* would not have been able to go near the termination frame for fear of getting tangled. We first brought in *Medea* for an eye-in-the sky view, to see if it was safe to send *Jason* in."

Medea is *Jason*'s mechanical teammate, an 800-pound platform that is tethered to the ship. Connected to *Medea* by a 100-meter cable, *Jason* can maneuver more freely, while *Medea*, hanging above, separates *Jason* from the motion of the ship at the surface and also provides wide-area camera and lights.

Ten tension-filled hours passed. In the end, they found the cable lying in great loops as much as 300 meters in diameter, but flat on the seafloor. Just at the edge of the coils of cable lay the termination frame, sitting upright, undamaged, and not embedded in the seafloor sediments.

"We were lucky," Chave said with considerable understatement. "The termination frame was two kilometers away from where we had planned, but we could definitely live with that."

Next, the junction box was lowered on a trawl wire and *Jason* was deployed to plug it in. Even with all that practice off the WHOI pier, Sellers said it wasn't exactly a piece of cake.

"The entire project depends on me putting that plug into the hole," he said. "So there are some stressful situations."

Chave put it another way: "I thought I had heard everything, but Will had some new words that I hadn't heard before."

Finally the plug was in, the system was installed, connected, and running, God was in His heaven, all was right with the world. . . and then twelve hours later, the junction box failed.

"Nothing ever goes as you plan at sea," Chave said. "You always have to be prepared to fix things. Since nobody had ever done this before, we had to improvise."

Thinking for the future, Chave and Wooding had designed the system so that the junction box could be retrieved relatively easily for repair or improvements without having to drag up the cable again. They just didn't think the future meant half a day.

Once again *Jason* was deployed. Sellers directed the ROV to snap a hook onto the "J-box" and hook it onto a lift line suspended from *Medea*, which hauled the 2,000-pound J-box back up. Time was running out because the ship was committed to move onto other scientific missions. The team made an overnight repair. The J-box was set down again on a wire. *Jason* plugged it in. Then, using a vacuum device on *Jason*, Sellers excavated a hole in the seafloor to embed H2O's first scientific instrument, an ocean bottom seismometer.

Soon, more instruments will be plugged into H2O, and someday the seafloor may be dotted with instruments monitoring a full spectrum of ocean phenomena. Unlike Neil Armstrong, Chave and company will not soon set foot on the seafloor, but H2O may also prove to be a giant step for humankind and the history of exploration.

Rhett Butler, IRIS

The junction box heads for the seafloor.

WHOI Waypoints

Tom Kleindinst

British Deputy Prime Minister John Prescott thanked members of WHOI's Deep Submergence Laboratory for their work on *Derbyshire*: (from left) Dana Yoerger, Tom Crook, P.J. Bernard, Will Sellers, Andy Bowen, Steve Lerner, Bob Elder and Jon Howland.

British Deputy Prime Minister Comes to Thank WHOI

On a whirlwind trip to the United States, which included a United Nations speech and a meeting with his counterpart Vice President Al Gore, John Prescott, the British Deputy Prime Minister, made a point of spending a full day visiting WHOI.

"I wanted to personally express the appreciation of seafarers and their families for what you did to determine the truth about *Derbyshire*," Prescott told members of WHOI's Deep Submergence Laboratory. He was referring to a 964-foot British ship that sank in a 1980 Pacific typhoon with 44 people onboard.

Ed Levy

WHOI Director Bob Gagosian outlines WHOI's proposed observatory on Martha's Vineyard.

"No one should underestimate the sheer anguish suffered by families who have lost people at sea and don't know how the ship was lost—they never, ever put it to rest until we can find out why," said Prescott, a former seaman. "We also learned something about the vessel so that we can prevent other vessels going down."

In 1997 the DSL team used its full suite of deep-sea exploration vehicles to search the wreckage of *Derbyshire*, which lay 2.6 miles below the sea surface. The evidence it collected showed that protective hatch covers near the ship's bow had failed, which let water into cargo areas and caused a stunning domino-effect that sank the ship in about three minutes.

In a letter to President Bill Clinton, British Prime Minister Tony Blair wrote: "This investigation was one of the greatest feats of underwater detective work ever undertaken....The survey results have shown that the marine community can now investigate accidents even in the deepest oceans....The outcome would not have been possible without the technology developed by the Woods Hole Oceanographic Institut[ion] who maintain the United States Deep Submergence Science Facility."

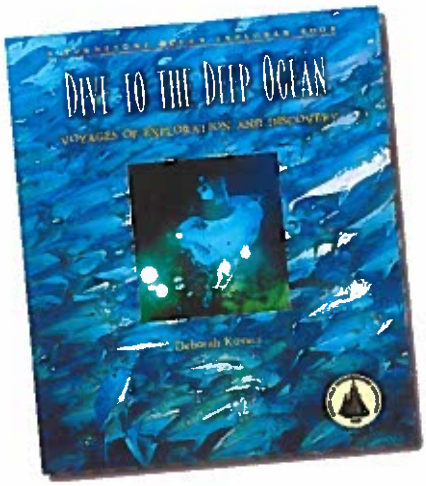
Prescott, whose portfolio includes transportation and the environment, toured WHOI with Director Bob Gagosian and later with US Congressman William Delahunt and received briefings from scientists on WHOI research. Meanwhile, Prescott's aides negotiated an agreement for Britain to work with WHOI to develop the next generation of *Jason*, the remotely operated vehicle that took part in the *Derbyshire* mission.

Ed Levy

WHOI Senior Scientist Bob Weller (right) briefs the DPM and US Congressman William Delahunt (left).

Sharing the excitement of oceanography

Promoting K-12 science education and the intellectual thrills of oceanography, Director Bob Gagosian was a featured speaker at the National Science Teachers Association's annual convention in Boston last spring. More than 21,000 teachers and others interested in education attended the four-day convention, and a standing-room-only crowd of some 600 joined Gagosian on a video tour of familiar and unfamiliar ocean worlds. Afterward, Gagosian was flooded with questions from the audience, and dozens of teachers surrounded him to learn more about WHOI's research and educational activities.



The convention marked the first public displays of new science books and classroom materials for grades 4-9 that feature WHOI scientists, research, and ships.

WHOI and Turnstone Publishing, Inc., a Boston-based publishing group founded in 1997, and Steck-Vaughn, a division of Harcourt General, are partners in education to produce a series of books and kits containing classroom activity and resource and display materials that use the ocean to stimulate science education.

Two days after his NSTA talk, Gagosian spoke to 450 educators and invited guests at the New England Aquarium at a reception hosted by Steck-Vaughn.

"Classroom activities and stories told by the scientists, engineers, and ships' crews at the forefront of scientific discovery give students a firsthand understanding of the concepts scientists grapple with every day and everywhere, from camps on Arctic and Antarctic ice to submersibles on the deep ocean floor," Gagosian said. "Students begin to recognize what motivates scientists in their work. Hands-on activities help students learn how scientists answer the questions they ask, and how many questions remain to be asked. The WHOI staff and I are delighted to share our excitement about ocean research and exploration with students and their teachers through our partnership with Turnstone and Steck-Vaughn."

Shelley Lauzon

WHOI Director Bob Gagosian (above) celebrates the first public displays of new oceanographic books for young students (left) at the National Science Teacher Association convention in March.

Marie Tharp Named 'Woman Pioneer'

In a gala tribute, the WHOI Women's Committee honored Marie Tharp with its Women Pioneers in Oceanography Award, given to "an outstanding female member of the oceanographic community who has made significant contributions to her field."

Starting in 1952, at first using sounding data taken aboard WHOI's *Atlantis*, Tharp and Bruce Heezen, working at Columbia University's Lamont Geological Observatory, began making detailed transoceanic seafloor profiles of the North Atlantic. Tharp's initial efforts revealed the first evidence for the rift valley in the Mid-Atlantic Ridge—which led soon after to the discovery of the continuous, 40,000-mile-long global mid-ocean ridge system. Over 30 years, Heezen and Tharp used all available data to systematically construct seafloor maps for all the world's oceans. Their maps played a critical role in advancing the revolutionary theories of continental drift and plate tectonics and gave humankind its first image of a spectacular, previously hidden landscape.

Tom Kleindinst

Marie Tharp was feted for her pioneering work to create the world's first seafloor maps.

A flurry of awards for WHOI scientists

Von Herzen Awarded AGU's Ewing Medal

Scientist Emeritus Richard P. von Herzen was awarded the American Geophysical Union's (AGU) 1998 Maurice Ewing Medal, one of the most prestigious awards in the field of earth sciences.

Von Herzen pioneered the field of geothermal research, leading global studies to understand the fundamental processes by which heat flows through the earth and the seafloor. He developed technology that revolutionized marine heat flow research, including the widely used Von Herzen probe for ocean sediment measurements, and thermal conductivity measuring devices and heat flow measuring systems for the submersible *Alvin* and for deep-sea drillholes.

Dave Gray

Richard P. von Herzen

"Von Herzen is undoubtedly the world's greatest researcher in the field of marine heat flow today," longtime colleague Seiya Uyeda of Tokai University in Tokyo, Japan, said in her citation for the award.

NOAA calls Anderson & Wiebe 'Environmental Heroes'

Two WHOI Senior Scientists, Don Anderson and Peter Wiebe, have received Environmental Hero Awards for their "tireless efforts to preserve and protect the nation's environment." They were among 34 individuals or organizations recognized this year by the National Oceanic and Atmospheric Administration.

Dave Gray

Don Anderson

Anderson is a world authority on harmful algal blooms (HABs)—the sudden, rampant proliferation of single-celled organisms that can have serious impacts on coastal resources, local and regional economies, and public health. He has led research efforts to understand and find remedies for HABs, which are occurring with greater frequency, and to develop the nation's first coordinated HAB research program. NOAA officials also said "he is the nation's strongest voice on HAB," addressing public officials, researchers, corporations, and health organizations on the impacts of US coastal blooms.

Wiebe was cited for leading the US Global Ocean Ecosystems Dynamics (GLOBEC) program to provide vital information on oceanic processes that control fish populations, as well as insights into declining fish stocks. Since 1994 he has coordinated scientists, research, cruise schedules, and data management on a project investigating the historically abundant fishing grounds on Georges Bank, and he is also launching a pilot program to involve local fishermen as full partners in the collection of oceanographic data to support fisheries research. His own research program has led to significant advances in technology development for tracking zooplankton on which fish feed.

Dave Gray

Peter Wiebe

Henry Dick elected AGU Fellow

At the AGU's spring meeting in Boston, Senior Scientist Henry J.B. Dick was one of 11 Fellows elected. He was honored at a ceremony and reception June 2 "for improving our understanding of the basic rock types making up the oceanic crust." Fellows are nominated by their peers, and only 0.1 percent of the AGU membership in any given year is so honored.

Frye, Walden, & Wirsen receive WHOI's Senior Technical Staff Awards

Dan Frye, Barrie Walden, and Carl Wirsen each received WHOI's Senior Technical Staff Award for their contributions to the development of oceanographic technology and their efforts to mentor younger staff.

Frye specializes in data telemetry from oceanographic instruments, buoys, and mooring systems and holds a patent for an oceanographic instrument. He joined WHOI in 1987 and in 1998 was named manager of the Applied Ocean Physics and Engineering Department's Advanced Engineering Laboratory.

Walden is manager of Operational Science Services, including WHOI's Submersible Engineering and Operations. He holds a patent for an underwater torpedo recovery device and is one of the principal investigators of WHOI's Autonomous Benthic Explorer (ABE), which is capable of working on the seafloor at depths of 20,000 feet for long periods of time.

Wirsen, a microbiologist and Research Specialist in the Biology Department, has worked at WHOI for more than 30 years, exploring microbial degradation of organic matter in the ocean and hydrothermal vent microbiology. He has served as scientist or chief scientist on more than 50 research cruises, has participated in more than 65 dives in deep submergence vehicles and holds a patent on a deep-sea high-pressure sampling device.

WHOI cruises generate fun and funding

Over the past decade, WHOI has chartered cruises for its Associates to exotic locales such as Antarctica, the Galápagos Islands, Iceland, and the Faroe Islands. The itineraries are designed to take Associates off the beaten track to areas rich in wildlife and natural splendor. They are accompanied by tour guides, naturalists, and WHOI scientists who provide insights on ecology and geology that the typical tourist would never get.

But the Associates not only get a taste of the science going on in the places they visit, they also get to spark new research. Profits from each trip are awarded to a WHOI scientist working in the cruise region. Besides fruitful studies, the awards have spurred mutually beneficial collaborations between WHOI scientists and international colleagues.

In 1997, profits from an Associates' trip to Antarctica allowed WHOI biologist Michael Moore to leverage substantial support from the US Marine Mammal Commission and other groups to survey whale distribution in the historically critical whaling area around South Georgia Island.

"Amusingly, as we docked at night in South Georgia, we passed the Associates' cruise that funded our work," Moore said.

Moore and colleagues found a severe lack of species such as blue and fin whales. The most common large species they found were southern right whales. They obtained important skin and blubber biopsies to compare with those of the much more endangered northern right whales and confirmed their suspicions that the northern right whales may have suffered short-term chemical exposures. Moore said he also established strong continuing ties with researchers on South Georgia.

WHOI File Photo

WHOI Research Associate Dorinda Ostermann removes sample cups from a sediment trap recovered aboard the Icelandic research vessel *Bjarni Sæmundsson*.

Zegrahm Expeditions, Inc.

WHOI Associates and staff members are a happy crew aboard the 1998 Associates cruise to Chile and Peru.

An award from the 1998 cruise to Peru and Chile went to WHOI's Education Program, setting the stage for formal graduate education and research ties between WHOI and the University of Concepción in Chile. Funds from the award are supporting two Chilean graduate students to conduct research at WHOI.

The 1999 award from the Associates' June cruise to Iceland was awarded to Research Associate Rindy Ostermann, and came just in time. Since 1985, Ostermann has doggedly maintained a sediment trap northeast of Iceland that catches the rain of particles falling through the ocean to the seafloor. By establishing the types of microorganisms that live today in these northern waters, scientists can use skeletal remains of these organisms preserved in seafloor sediments as a window onto past ocean and climate conditions. Each year, Ostermann arranges to share data with Icelandic colleagues in exchange for a ride on an Icelandic research vessel, and she scrounges together enough funds to do the work.

"This money enables us to maintain the mooring and monitor phenomena that may occur over decades or may only occur uniquely," Ostermann said. "The timing of the award is perfect, too, because in the past few years, an unusual branch of the Gulf Stream has been pushing a great tongue of warmer salty water to the north of Iceland from the west. By next year, this tongue will encompass our mooring station. If we find that the warmer waters bring species that aren't normally found there, we can make inferences about the occurrence of this warm current intrusion into northern Icelandic waters in the past, based on the warm-water species found in sediments below the mooring."

The next Associates' trip is a circumnavigation of New Zealand, Jan. 28 to Feb. 13, 2000. For further information, please call Lesley Reilly at (508) 289-3313.

Some ABCs about IRAs

Did you know?

- Pending federal legislation would allow individuals to roll assets from an IRA over to a charity without tax liability. This could be a wonderful alternative for those who have reached 70 ½ (the mandatory age to withdraw IRA funds) and are in the enviable position of not needing additional income.
- Currently, beneficiaries of IRAs cannot assign IRA income to charity without paying income tax on the proceeds.
- Under present law, the best way to donate an IRA to your favorite charity and avoid taxation is to bequest it through your will.

For breaking news on IRA legislation, or on ways to make a planned gift to WHOI, please contact Jane Bradford, Director of Planned Giving, at (508) 289-3359.

Leviathan Forensics

Vincent DeWitt, Cape Cod Times

Staccato's Loss Is a Serious Blow to Dwindling Right Whale Population

In the predawn hours of April 21, WHOI biologist Michael Moore was on a Wellfleet beach helping to drag ashore a dead 50-ton, 45-foot northern right whale. She was named Staccato when scientists first identified her in 1974. Ever since, via intermittent sightings, they had tracked her movements and her life, including the births of six calves, until April 20, when she was found floating dead in Cape Cod Bay.

Only 300 northern right whales exist, so losing any one, especially a reproductive female like Staccato, is a blow. Over the next three days, Moore was part of the 40-person team that performed a necropsy on Staccato, which revealed a broken jaw, five fractured vertebrae, internal bleeding, damage to the whale's left pectoral flipper, as well as indications of acute and chronic disease.

After further laboratory analyses of tissue gathered during the necropsy and a weighing of all the evidence, the team concluded that a ship strike most likely caused the injuries that killed Staccato.

"We have a strong sense of duty to provide unbiased information, because the results of the necropsy have a direct impact on the management of the species and have enormous ripple effects on the shipping and fishing industries," Moore said.

"It was a privilege to be a part of the necropsy," he said. "The sheer size of these animals makes them awe-inspiring when you're standing on the beach. Emotionally, there's an enormous amount of adrenaline, which makes up for the lack of sleep. But once you are finished, it becomes an incredibly depressing event.

"It is partly due to fatigue, but it surprised me how depressing it was, especially coming on the heels of Hal's paper," he said, referring to a recently published study by WHOI Senior Scientist Hal Caswell on the right whales' declining population trend (see page 3). "We were packing the bones of what might be the last generation of a very magnificent species."

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