Volume 8, Number 3 • 2000 • Published by the Woods Hole Oceanographic Institution

WOODS HOLE Currents

MIT/WHOI Joint Program

An Unprecedented Venture

In Higher Education

Part II

WOODS HOLE
Currents
Volume 8, Number 3 • 2000

Tom Kleindinst

Working side by side, WHOI Associate Scientist Kathleen Ruttenberg (left) and MIT/WHOI Joint Program graduate student Kristen Laarkamp measure concentrations of phosphorus in ocean samples. Phosphorus is an important nutrient that influences plankton productivity in the oceans.

On the cover: Established 32 years ago, the MIT/WHOI Joint Program has begun to span generations and continents. Susan Wijffels '93 (physical oceanography) consults with her advisor, Harry Bryden, who earned his Ph.D. from the Joint Program in 1975 and was a scientist at WHOI from 1977 to 1992. Bryden crossed the Atlantic to become a researcher at the Southampton Oceanography Centre in England. Wijffels is now a scientist at the Commonwealth Scientific and Industrial Research Organisation, Australia's largest scientific research agency. *Photo by Tom Kleindinst*

The historic photos in this issue are largely from former Associate Dean Jake Peirson's collection. Our thanks to the photographers, many of whom we could not identify.

The Woods Hole Oceanographic Institution is a private, independent, not-for-profit corporation dedicated to research and higher education at the frontiers of ocean science. WHOI's primary mission is to develop and communicate a basic understanding of how the oceans function and interact with the earth as a whole. The Institution strives to be a world leader in advancing knowledge about the oceans and explaining their critical role in the global environment.

Published by the Woods Hole Oceanographic Institution
Woods Hole, MA 02543
508-457-2000
www.whoi.edu

Editor: Laurence Lippsett

Designer: Jim Canavan, WHOI Graphic Services

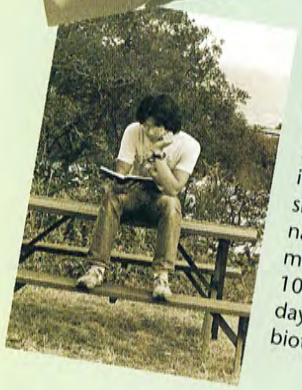
For membership information, write to: Development Office, Woods Hole Oceanographic Institution, Woods Hole, MA 02543. (508) 289-4895. E-mail: development@whoi.edu. Internet: www.whoi.edu.

A calendar-year *Woods Hole Currents* subscription is available for $15 in the US, $18 in Canada. The WHOI Publication Package, including *Woods Hole Currents* and *Oceanus* magazine (a semi-annual publication on oceanographic research), is available for a $25 calendar-year fee in the US, $30 in Canada. Outside North America, the annual fee for *Woods Hole Currents* only is $25, and the Publication Package costs $40. To receive the publications, please call (toll free) 1-800-291-6458, or write: WHOI Publication Services, P.O. Box 50145, New Bedford, MA 02745-0005.

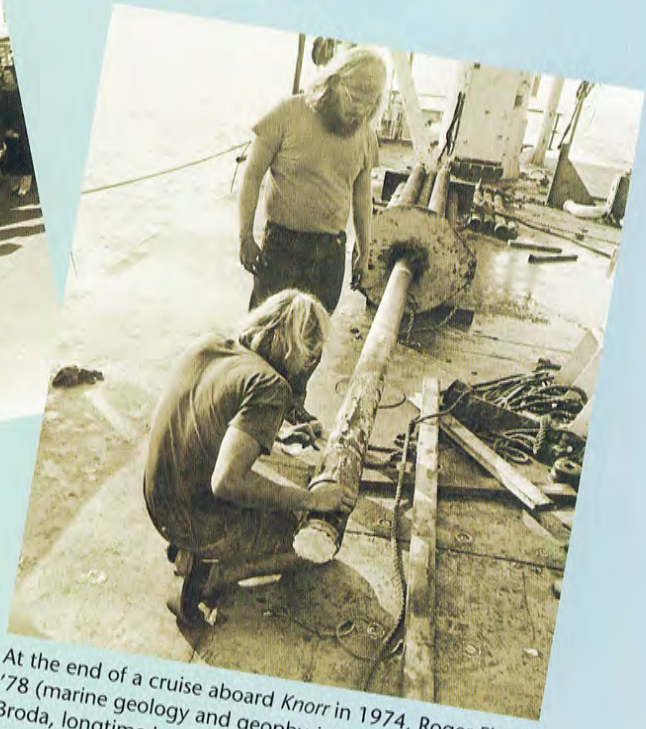
Woods Hole Oceanographic Institution is an Equal Employment Opportunity and Affirmative Action Employer.

Printed on recycled paper

Commencement Day at WHOI, 1980



Glenn Sasaki '84 (biological oceanography) is moving at a faster pace these days as a group leader at Aurora Biosciences in La Jolla, CA. He designs and develops precision instrumentation for dispensing very small amounts (picoliters to nanoliters) of reagents in automated technology that perform 100,000 drug discovery assays per day for the pharmaceutical and biotechnology industries.



At the end of a cruise aboard *Knorr* in 1974, Roger Flood '78 (marine geology and geophysics), standing, and Jim Broda, longtime head of WHOI's core lab, retrieve a sample with a corer assembled from leftover pipe cannibalized from other experiments. Flood is now a professor at the Marine Sciences Research Center at the State University of New York, Stony Brook.

The MIT/WHOI Joint Program

Having two great parents has its advantages

Our last issue of *Woods Hole Currents* highlighted how the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution joined in an unprecedented academic marriage, creating the Joint Program for graduate studies in oceanography in 1968. Both institutions have profited from the relationship, and so have its offspring—the students.

"MIT and WHOI represent a wonderful partnership," said MIT Chancellor Lawrence Bacow. "Our Joint Program students prosper from being able to sample from the complementary strengths and capabilities of two great institutions."

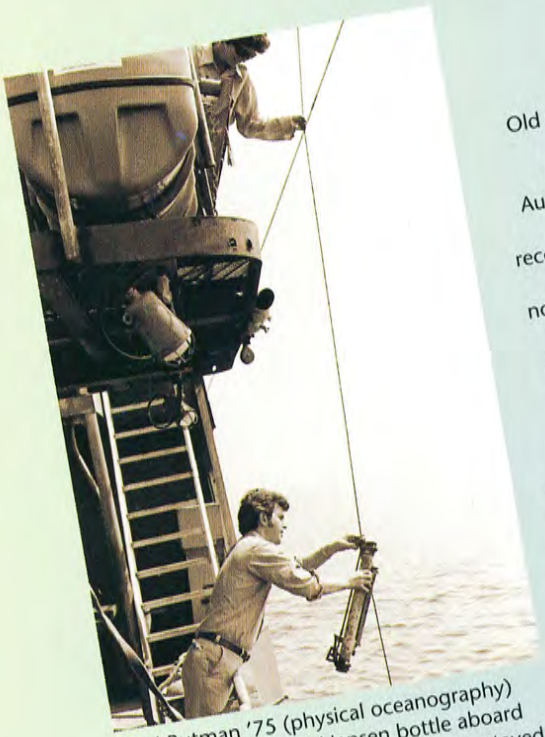
"One of the great strengths of the Joint Program is the breadth and depth of learning, advice, and mentoring that students can get, given the combined resources of MIT and WHOI," said John Farrington, the current WHOI Dean of Graduate Studies. "Students have access not only to traditional faculty, but they also come in contact with working scientists and a wide range of technicians who make measurements in the ocean and invent and build new instruments."

So no matter what field students focus on (biological oceanography, chemical oceanography, marine geology and geophysics, physical oceanography, or applied ocean science and engineering), they all are exposed to the pillars of a fundamental oceanographic education, Farrington said. They learn basic theories, make observations of phenomena, and conduct experiments. Then they use those observational and experimental data to create and test new theories.

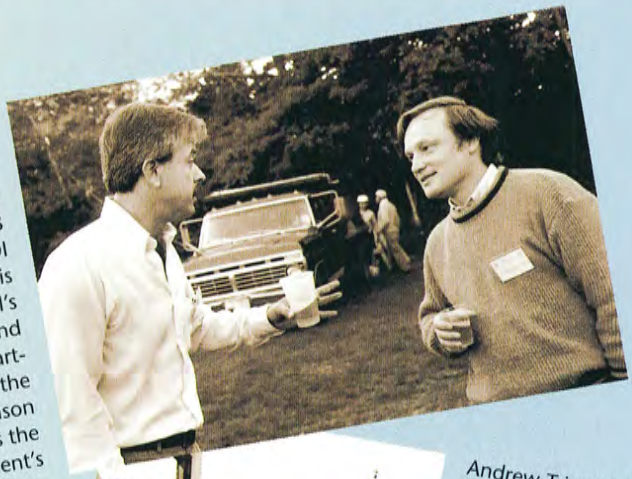
Exposure to complementary approaches provides advantages, as does exposure to complementary campuses—one with all the rich cultural opportunities of an eclectic metropolis, the other full of physical beauty and small-town charm. Both campuses attract parades of world-class scientists who engender a stimulating scientific community and keep students on the cutting edge of oceanographic research.

"There are few other oceanographic institutions where you could go to a seminar given by a leading researcher, either local or visiting, several times per week," said Susan Henrichs '80, now a professor at the University of Alaska.

"I often felt I was at the nexus of oceanographic research," said William Spitzer '89.



Brad Butman '75 (physical oceanography) prepares to launch a Nansen bottle aboard R/V *Oceanus*. Since graduation he has stayed on campus—as an oceanographer at the US Geological Survey in Woods Hole.



Old marine geology and geophysics classmates Jamie Austin '79 (left) and Bob Detrick '78 reconvene at a WHOI reunion. Detrick is now Chair of WHOI's Geology and Geophysics Department and holds the J. Seward Johnson Chair as the department's Educational Coordinator. Austin is a Senior Research Scientist at the University of Texas Institute for Geophysics and president of the Joint Program Alumni/ae Association.

Andrew Trivett '91 (oceanographic engineering) has worked with several startup companies in Canada developing new technology products. These include a system recently demonstrated on a Canadian Coast Guard icebreaker to reduce emissions from large marine diesel engines, and "shape-Tape," a 3-D fiber-optic sensor that measures human body motion and is used for real-time robotic control.

But perhaps the most important foundation that the institutions provide is financial: "We take responsibility for supporting our students for the full five or six years it takes to earn their degrees," Farrington said. Several student fellowships not only lighten a considerable financial burden, they also free students from having to pursue another scientist's already financed research. Instead, students can choose their own original thesis topics, find the right advisors, and make adjustments if necessary.

"I found the program to be extremely flexible," said Bob Detrick, a 1978 graduate and now a WHOI scientist advising his own JP students. "It gave students a lot of responsibility and independence to pursue their research interests. The program treated students as junior scientists." That hasn't changed. Students today, said Associate Dean Judy McDowell, "are able to be 'scientists in training.'"

"The Joint Program has had a major impact on my career and on WHOI," said WHOI Director Bob Gagosian. "I was fortunate to have worked with many great students during my years as an active scientist. And now in my current position, I recognize the essential role graduate students have played in making WHOI a national treasure—a global leader in going to sea to understand how the oceans work."

Not infrequently, student-initiated research broadens research horizons. A classic example was the discovery by Cindy Van Dover '89 of a novel light-sensing organ on a unique species of shrimp that lives at hydrothermal vents on the Mid-Atlantic Ridge. She put a special camera on the *Alvin* submersible and discovered the surprising phenomenon of "vent glow"—which continues to be an active target of scientific inquiry at WHOI today.

Van Dover received support beyond her fellowships from the Ocean Ventures Fund, established with private donations "to provide money for high-risk ideas by young, unproven scientists." And there are other similar funds. Since 1986, The Frank W. Tchitcherine Student Opportunity Fund has supported students' attendance at meetings and workshops, where they can meet and exchange ideas with colleagues from around the world. The Ditty Bag Fund, created by an anonymous gift and named after the little bag sailors once used to hold small essentials, also helps students seize unexpected opportunities to advance their work.

Support of a different type comes from the Joint Program's faculty. "My advisors really cared about me as a student," recalls Jamie Austin, a 1979 graduate who is now senior research scientist at the University of Texas Institute for Geophysics and president of the Joint Program Alumnae/i Association. That support came right from the top.

"As a second-year graduate student in late 1975, I was in Clark waiting for the shuttle," he related. "WHOI Director Paul Fye came by and said, 'Jamie, would you like a ride downtown?' In that seven- or eight-minute trip in his big blue Oldsmobile, he told me about my dissertation, my advisor, and everything else. The director knew who I was. He became an icon for me from then on—the embodiment of why it was a great place."

Like proud parents displaying wallet-sized photos of their children, we present a few more profiles of our Joint Program graduates on the following pages.

Tickling the Ivories And Tackling the Pacific

Lynne Talley feels equally comfortable at the keyboard of a piano or a computer.

As a physical oceanographer at Scripps Institution of Oceanography (SIO), Talley has played a major role in orchestrating international experiments to probe the world's oceans and has served as chief scientist on many research cruises during the past 20 years. After majoring in music and physics at Oberlin College, Talley enrolled in the MIT/WHOI Joint Program in 1977. In Woods Hole, she didn't just pursue the graduate student grind; she also practiced and performed her second love: music.

"There's a big correlation between music and physics," Talley said in her office in La Jolla, CA. "And Woods Hole was a wonderful place for music."

Talley recalls the summer concert series at the Marine Biological Laboratory, where she gave solo piano recitals and teamed with Olivann Hobbie and MBL biologist Jelle Atema for piano/flute duets.

"It's fun to do, but there's also lots of precision and counting," said Talley, who read music at age six and studied at a German music conservatory after college. "I found it tremendously important as an emotional outlet. It's abstract, but you can emote while you do it, which you certainly can't do while writing your theories."

Talley worked with WHOI scientists Michael McCartney and Joseph Pedlosky, completing a thesis on the instability of large-scale currents, such as the Gulf Stream, and publishing several papers about water properties of the North Atlantic. She was a postdoc at Oregon State University before she became an assistant research oceanographer at SIO in 1984 and is now professor of oceanography.

Since 1987, she has helped lead the World Ocean Circulation Experiment, a multi-national effort to describe ocean circulation in every ocean except the Arctic and Mediterranean Sea. The ultimate goal of WOCE, which ended fieldwork in 1998, is to improve circulation models, leading to better long-term climate prediction.

Several hundred scientists have been involved in the project. Talley co-wrote plans to study the Pacific and Indian Oceans and co-chaired several high-ranking WOCE committees. The door to her office is plastered with maps of WOCE ship tracks crisscrossing five oceans.

"In the North Atlantic, I thought I was looking at a big problem, but with WOCE you have to change your mind-set," Talley said. "Maybe we really can look at the whole world and learn how all the oceans are connected."

Richard Lambert, director of the National Science Foundation's physical oceanography program and the person responsible for government funding of WOCE, said that Talley is a "big-idea" person whose insights were key to the worldwide experiment's success.

Physical oceanographer Lynne Talley '82 has helped lead multi-national efforts to unravel the circulation of the world oceans.

After years of collecting data, researchers like Talley are now analyzing and interpreting them. Talley is working with Joint Program graduates around the world—John Toole '80, Gregory Johnson '85, Susan Wijffels '93, and Paul Robbins '97—on the circulation of the entire Pacific Ocean. She herself is responsible for making an atlas of 13 different kinds of water measurements in the Pacific. The challenge for physical oceanographers is to continue to unravel the role that the ocean's circulation plays in governing short-term climate changes such as El Niño, as well as long-term trends, she said.

In the meantime, Talley went to sea again aboard SIO's R/V *Revelle* last summer to study the deep-water currents of the little-explored Sea of Japan. On this mission, there were no guarantees. Talley and *Revelle* were barred from Russian territorial waters, which are off-limits to foreigners. So she took measurements in Japanese waters along with a crew of Russian scientists for three weeks. Then she transferred US scientific equipment to a Russian research vessel in an effort to obtain the information she needs to understand how and where the region's deep water is formed.

It wasn't an ideal situation, but science isn't immune from politics. In fact, North Korea won't allow any scientific missions in its waters. Talley said the deep convection layer she is looking for may come from the North Korean side of the Sea of Japan, "but we'll have to infer it," she said. Understanding the deep-water dynamics of an enclosed ocean basin such as the Sea of Japan will yield insights into the development of larger basins, such as the North Atlantic, she explained.

Talley laughed when asked if she likes going to sea. She'd rather be at home with her nine-year-old son Max and playing the piano, something she does every Sunday morning at her Unitarian church and at local amateur contests.

"I'm not an oceanographer because I like going to sea," she admitted. "I'm an oceanographer because I like physics."

—Eric Niiler

Out of the Academy and into the Aquarium

Billy Spitzer '89 (left) and Michael Connor '80 don playful costumes of sea creatures to promote the new "Sounds of the Sea" exhibit at the New England Aquarium, where the two are, respectively, Director of Education and Vice President of Programs and Exhibits.

William Spitzer and Michael Connor both graduated from the MIT/WHOI Joint Program with no intentions of ever working in a laboratory or ivory tower.

For the two, science has always been a means to another end. Connor's formative college years at Stanford coincided with the first Earth Day and passage of the Clean Water Act, and he often brought his organic chemistry textbook to sit-ins protesting the Vietnam War. For him, science held the key to making smarter public policy decisions with greater benefits to society.

For Spitzer, science unlocked another door. It could tickle people's natural curiosity and unleash a flood of questions about their world. Then it could teach them how to get the answers. In short, it could educate and empower.

So it's not entirely coincidental that today the two men find themselves in leadership positions at the New England Aquarium in Boston, with its mission to "protect, promote, and present the world of water." As director of education, Spitzer shapes the aquarium's ever-growing educational program, the largest of its kind, to teach visitors about oceans, rivers, and ponds and to use these as learning resources. As vice president of programs and exhibits, Connor steers a very public agenda to explain threats to the ocean, to take part in fishery management debates, and to conduct research to conserve coral reefs and marine diversity.

"In some ways the most valuable thing that I learned at Woods Hole was the importance of being thoughtful, skeptical, rigorous, and logical about things and, most important, just being curious."

For Connor, the direction, if not the destination, was always clear. As an undergraduate, he took a year off to work at a small rural school in South Korea, where he got a firsthand look at Asia's pollution problems. He came to Woods Hole partly because of an interest in a nearby institute that was exploring alternative energy and aquaculture.

At WHOI he took an active role in graduate student seminars convened by his advisor, Senior Scientist Emeritus John Teal, which explored ways to apply science to practical problems. "Teal was really unique in that he encouraged us to seek the policy side of everything we did," Connor said. One seminar concerned research on Georges Bank, 70 miles east of Cape Cod. He and his fellows, who came to be known as "the students in fishermen's sweaters," became active participants in the public debate, in the wake of the OPEC oil embargo, on a controversial proposed moratorium on oil drilling there. Another seminar examined the environmental degradation caused by the dumping of 50 dry tons of raw sewage into Boston Harbor every day.

After graduating from the Joint Program in 1980 with a degree in biological oceanography, Connor took a post–doctoral position in environmental policy at the Harvard School of Public Health. The 1972 Clean Water Act had made sewage disposal a contentious issue for coastal communities, and he analyzed various options for wastewater and sludge, which included burning it, dumping it into the ocean, or recycling it into fertilizer. He worked for the Environmental Protection Agency, analyzing ways to manage estuary systems such as Long Island Sound, Narragansett Bay, and Buzzards Bay. Then he did similar work on estuaries around the country as a consultant for Batelle Ocean Sciences in Duxbury, Massachusetts. At Batelle, he made his first (unsuccessful) attempt to persuade the Massachusetts Water Resources Authority (MWRA) —the agency that controlled discharge into Boston Harbor—that scientific studies could help find the most effective methods to solve its dumping problem.

Then in a twist of fate, the New England Aquarium, Connor's current employer, hosted a conference on harbor pollution in 1987. Judy McDowell, a WHOI biological oceanographer and now the Joint Program's Associate Dean, was scheduled to give a talk, but was snowed in. At the last minute, Connor, who had come to the conference just to listen, was asked to fill in. An MWRA staff member in the audience was impressed by Connor's improvised talk on the effects of dumping on the Massachusetts Bay ecosystem.

"She said, 'This guy is really understandable. He can communicate science in a way that the public can understand,'" Connor related. She recommended Connor to head the MWRA's Environmental Quality Department.

"The MWRA was an agency of sewer engineers," he said. "I was the first scientist. When I arrived, I met the attitude of 'We don't need science, we need answers.' However, we essentially got together with scientists and policymakers and helped turn the science into answers."

By the end of his 10-year MWRA stint, Connor had transformed his one-man mission into a $7.5-million effort involving 75 staffers and a new laboratory facility on Deer Island. He launched new research that provided a rational basis for analyzing the risks and benefits of a plan to build an outfall system that would circumvent the harbor and release wastewater miles off the coast. He established protocols to test and monitor the system. To an often confused and angry public, Connor explained the scientific thinking and evidence behind the plan, the knowns and unknowns, the possibilities and contingencies. Today, the system he played a big role in installing has halved sewage output into the harbor and reduced bacterial contamination to a 50-year low.

Looking out at the now-cleaner Boston Harbor from his office window at the aquarium, Spitzer said he knew in graduate school that the chemistry between people excited him even more than the chemistry between molecules.

"I really wanted to have the experience of doing research, but not necessarily my whole life," he said. "I needed something that was more directly service- and people-oriented."

At WHOI, Spitzer immersed himself in Woods Hole's vibrant scientific community, attending seminars on cutting-edge discoveries in marine science or discussing experimental design with colleagues. "People were always talking about their work and I learned not to be afraid to ask hard questions and to be asked hard questions," he said.

Answering those questions, he learned, usually involved overcoming obstacles, thinking things through carefully, applying new knowledge in innovative ways, and learning some hands-on skills. While completing his dissertation research in chemical oceanography on oceanic gas cycles, he was confronted with the dilemma of constructing experiments that wouldn't fall apart on the high seas or be ruined during power outages. "If it meant learning plumbing or how to solder, that's what you did," Spitzer said.

Mike Connor helps fellow JP student Robert Howarth '79 prepare to dive in Buzzards Bay. Howarth is now the David R. Atkinson Professor of Ecology & Evolutionary Biology at Cornell and Chair of the National Academy of Sciences' Committee on Causes and Management of Coastal Eutrophication.

The ingenuity of his advisor, former WHOI Senior Scientist Bill Jenkins, provided plenty of inspiration. "He would go home over the weekend and read some book about a whole new field and then come back the next week and start using it. I was empowered just to know that you could do that.

"In some ways the most valuable thing I learned at Woods Hole was the importance of being thoughtful, skeptical, rigorous, and logical about things and, most important, just being curious," he said. "It's really independent of the particular subject matter—it's a way of thinking."

Billy Spitzer talks with former WHOI scientist Ellen Druffel during his student days.

Spitzer found that "way of thinking" served him well in his first position after graduating in 1989: directing research in science education at the Technical Education Research Center in Cambridge, Massachusetts. He said he often drew upon the research skills he had learned as he developed new ways to teach children about air pollution or biodiversity. Instilling in students and teachers an understanding of experimental design—how to build a hypothesis through exploration, then collect data to test it—became his ultimate goal as an educator.

Since 1996, Spitzer has had a hand in every educational function of the aquarium, from writing exhibit text to answering visitors' questions. He has led the education department to implement ambitious outreach and education programs. These range from the largest skill and leadership development programs for teen-agers in the Boston area to teacher workshops, Elderhostel programs, "Beach Teach" for preschoolers, and Science League, a pilot project modeled after youth athletic leagues. The aquatic world can help teach anything, Spitzer argues, from basic literacy skills at lower grades to advanced high school science.

For both Spitzer and Connor, the New England Aquarium offers a stage for scientists to debut their research and spotlight environmental concerns to an audience of 1.4 million visitors annually. Neither has forgotten his MIT/WHOI roots. Spitzer has collaborated with WHOI alumnus Richard Signell and WHOI biologist Larry Madin, respectively, on exhibits about Georges Bank and ocean jellies, and with WHOI biologist Peter Tyack and MIT professors Art Baggeroer and Henrik Schmidt on a "Sounds of the Sea" exhibit.

And in late 1999, as the Canadian government was deciding whether to extend its moratorium on Georges Bank oil drilling, Connor revisited an early environmental concern, co-chairing a report by WHOI and aquarium scientists on offshore drilling on the bank.

—Rebecca Pollard

Shaking up the Oil Patch

Better oil exploration through geochemistry

Mark McCaffrey belongs to the rare breed of scientist who occasionally stops dead in his tracks and asks the hardest questions of all: Why am I doing this? Am I still having fun?

Since graduating from the Joint Program in 1990, he has made contributions to the field of geochemistry out of proportion to his youth: publishing 28 papers in nine years and pioneering geochemical methods to improve oil exploration and production at Chevron and ARCO. In 1996, he won the European Association of Organic Geochemists' Pieter Schenck Award for outstanding contributions from a geochemist under age 35. Not exactly what you'd expect from a high school dropout.

Mark McCaffrey receives his doctoral hood in 1990 from WHOI Director Craig Dorman '72 (center) and Frank Perkins, Dean of Graduate Studies at MIT. At left is former WHOI Director John Steele.

Born in Larchmont, NY, Mark moved after his parents divorced to Charleston, SC, where he struggled to pay tuition for private high school. He tutored students in algebra, biology, and calculus, and bused tables at a restaurant in the summer. "I was so miserable working all the time to pay for school," he said, "that I decided to drop out after my junior year—not a decision popular with my mother."

Even without a high school diploma, his high grades and SAT scores got him into the College of Charleston that fall. There, his continued academic excellence won him a rare transfer to Harvard as a freshman in 1981. This began his most critical transition: a kid from the South, without the advantages of wealth, thrown into the intellectual cauldron of Cambridge.

"For the first time," he said, "I saw that everything I had been taught about the Civil War was wrong. It was just one eye-opener after another." At the end of his first semester he sought out the person who had handled his admissions application. "I showed her my report card, with three As and one B+, and said, 'I just want you to know you made the right decision.' 'That's good,' she said, 'because you were in and out of the acceptance pile several times.'"

"I get an immediate rush when I see people using my methods to find more oil for less money and at less risk."

During his freshman year, a creative fire ignited by Stephen Jay Gould's course "History of Earth and Life" was fanned by his Harvard mentor, H.D. Holland, an inorganic geochemist, who suggested that McCaffrey investigate the minerals that precipitate from evaporating seawater. "I liked the topic because it was broad," McCaffrey said, "but also because it had a field component"— to a sparsely inhabited island paradise in the Bahamas where Morton Salt makes road salt from seawater. His resulting bachelor's thesis remains one of his most cited papers, drawing readership from both academic and commercial scientists interested in seawater-derived minerals.

While at Harvard, he landed a summer job at Union Texas Petroleum in Houston, where he cut slabs from rock cores extracted from oil wells to assess the petroleum potential of an area. The next summer he plotted acoustic reflections used to locate subsurface rock structures that might contain hydrocarbons. Those summers kindled a feeling that the chemistry of carbon—organic chemistry—might be the most fun and the most useful.

After he graduated from Harvard magna cum laude with highest honors in geological sciences, McCaffrey enrolled in the Joint Program, intending to stick to the more academic, noncarbon world of inorganic chemistry. But by the end of the first year, he kept thinking that the field offered limited opportunities to "make a difference in the world."

"I was looking at trace elements in marine sediments, and I couldn't see spending my days marching through the isotope alphabet, from boron to zirconium. I wasn't happy and kept thinking I should have gone to med school. I kept

thinking, 'Why am I doing this?'"

McCaffrey met John Farrington, a chemical oceanographer and now Dean of Graduate Studies at WHOI. While at Harvard, McCaffrey had been impressed by one of Farrington's papers on using seafloor sediments off Peru to reveal past El Niño events.

"I was casting around for something," McCaffrey said. "The great thing about the Joint Program is that you are permitted, even encouraged, to explore in the first two years. For me, it was a lifesaver when John said, 'Why don't you come work in my lab?'"

McCaffrey had never taken organic chemistry, not even an introductory course. He began a crash tutorial guided one-on-one by WHOI scientist Jean Whelan. Working by day in Farrington's lab, he studied late nights to pass Whelan's once-a-week exams. "It was amazing that they allowed me to do that," he said. "Once you see what your options are, the program has the resources and openness to allow you to seek what excites you."

Passing organic chemistry, McCaffrey built on the work started by Farrington and a previous Joint Program student, Susan Henrichs. His doctoral dissertation showed that certain chemical compounds in seabed sediments could indeed flag certain depositional conditions, including those associated with El Niño events of the past 150 years.

From the Joint Program, he went to Chevron, then a mecca for pioneering geochemical applications for the oil industry. Oil is made from organic matter incorporated into sediments that are deposited and subsequently buried. The oil contains molecular fossils, called biomarkers, that can help identify the original organisms that contributed organic matter to the sediments. By identifying the organisms, scientists can date the oil.

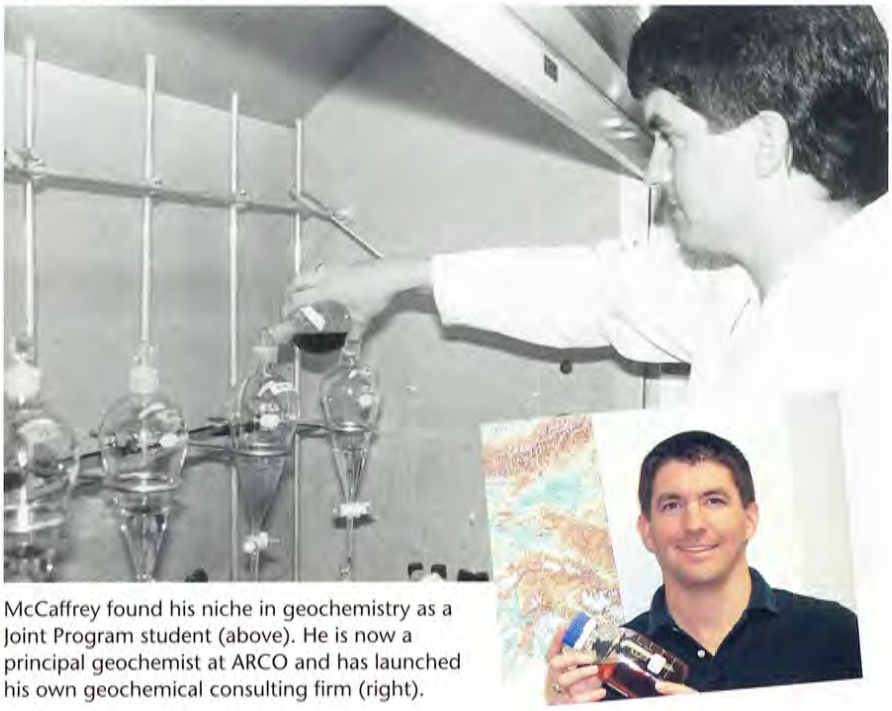
Working on biomarkers, McCaffrey and colleagues identified an entirely new class of steroids and suggested that they were a previously unrecognized product of marine bacteria, which generally do not make steroids. The work resulted in a significant paper in *Nature*, co-authored with Jeremy Dahl and Michael Moldowan. McCaffrey had the thrill of extending the taxonomy of steroids—like a lepodopterist discovering a new species of butterfly. Though the discovery had no immediate application, his line of inquiry soon paid off.

In East Siberian oils, he linked certain unusual steroids in oil with 500- to 700-million-year-old sponges from the Cambrian and late Precambrian eras. At last, a chemical indicator could be used to date very old oils and accurately distinguish them from younger oils—an important tool for evaluating the petroleum potential of certain regions. He and co-workers subsequently developed methods using biomarker distributions in oils to predict petroleum potential in different regions. The method is now a widely used petroleum exploration tool. Organic chemistry, the chemistry of life, was delivering on the promise of "making a difference in the world."

The work was fun, but research funds in the oil industry began to dry up in the mid-1990s, and McCaffrey's research specialization put him at the mercy of a large company. He thought about pursuing an MBA. But after rejections from Stanford and Harvard, McCaffrey was back in the lab, wondering if the fun would disappear for good.

Then came a propitious phone call from Europe: He had won the second Pieter Schenck award for his application of biomarkers to petroleum exploration. It was an organic geochemist's equivalent of winning a Pulitzer Prize. "It pulled me back to staying in the industry," McCaffrey said.

Leaving an uncertain future at Chevron, he became principal geochemist with ARCO, where he has developed new ways to assess the potential of proposed petroleum exploration sites. On the production side, he has developed chemical methods to distinguish the contributions from separate zones of oil into a commingled flow—an approach that can save thousands of dollars per well.



McCaffrey found his niche in geochemistry as a Joint Program student (above). He is now a principal geochemist at ARCO and has launched his own geochemical consulting firm (right).

In December, McCaffrey and his old Chevron colleague Jeremy Dahl launched their own company, OilTracers L.L.C. (www.oiltracers.com). They apply their geochemical expertise to solve problems for clients throughout the petroleum industry, especially smaller companies that have no in-house geochemical capabilities.

"What I find exciting, and what I think every scientist wants," McCaffrey said "is to somehow change the way people think or behave. You can do that through basic research, or in the academy. But in my work, I get an immediate rush when I see people using my methods to find more oil for less money and at less risk, and I think 'Wow, I did this, and people are using it every day.' I don't think it gets any more fun than that."

— James M. Kent

Oceanographer in Orbit

Astronaut alumna has dual perspective on inner & outer space

"I wanted to be an astronaut ever since I saw Neil Armstrong set foot on the moon." Millions of average Americans could have said that. But Wendy Lawrence is not your average American, or your average astronaut.

More than 3,000 men and women apply every two years to be NASA astronauts, but only 30 or so are selected. Lawrence, a US Navy helicopter pilot, got the call in March 1992 to join the 300 or so men and women who can put the word "astronaut" on their résumé and epitaph. She is one of about 150 active astronauts and may someday be among the select few who populate the International Space Station.

"I followed the same path as many astronauts have before me—through the military," Lawrence noted. She graduated from the US Naval Academy in 1981 and then was asked to attend the MIT/WHOI Joint Program in a Navy initiative to beef up its officers' scientific knowledge. "It was a reward to go to WHOI and get to work with such a well-rounded group of people," she said. And the master's degree in ocean engineering that she earned in 1988, she said, was one of the "key things that helped get me selected to be an astronaut." The MIT/WHOI degree, she said, "set me apart from the others. I had gotten a quality education from a rigorous program." The fact that she had researched and published a thesis certified her as an officer of noteworthy intellect—one who could handle the rigors of space flight *and* the precision of space-borne experimentation.

As a Navy aviator for 11 years, she logged more than 1,500 hours and 800 ship landings, making her a natural candidate to serve as a flight engineer and orbit pilot on the space shuttle.

"It took 25 years for my dream to come true," said Lawrence, who made her first space shuttle voyage on *Endeavor* in March 1995. "The greatest memory from that trip was my first chance to look out the window. An entire life of work became worth it with just one look. I was finally there, and it was humbling. I remember thinking 'Why me?' and 'Why am I so fortunate?' We live on an amazingly beautiful planet."

NASA

Wendy Lawrence gets a final check of her flight suit just before the launch of her space shuttle mission in 1998.

"The flight really gave me an increased sense of respect for taking care of this planet," she said. From 200 miles high, with the eyes of an oceanographer, she could observe eddies, internal wave patterns in the ocean, alongshore currents, and sediment transfer at the great river deltas off India.

"The greatest memory from that trip was my first chance to look out the window.... The flight really gave me an increased sense of respect for taking care of this planet."

That awesome glance marked the beginning of more than 894 hours in space for Lawrence. She would later fly in 1997 and 1998, but then came her rewarding and frustrating relationship with the Russian *Mir* space station. For several months, she trained as the backup to astronaut John Blaha for the fourth shuttle-*Mir* docking mission. But shortly before the flight, the Russians declared a 164-centimeter minimum height requirement for astronauts in the Soyuz capsule, *Mir*'s escape ship. Lawrence stands 160 centimeters (5 foot 3 inches).

"Height in the capsule is critical," Lawrence said. "Astronauts who do not fit properly into the seat could snap their necks" on the bumpy ride through Earth's atmosphere. Trained but not qualified for *Mir*, Lawrence later assumed the role of NASA's Director of Operations at the Gagarin Cosmonaut Training Center in Star City, Russia.

She helped her fellow Americans

prepare for long-term flight, Russian style, and served as a liaison between one-time competing space programs. During that tour she discovered that "sitting height" was more important than "standing height" for fitting into *Soyuz* and that she sat tall enough to render the 164-centimeter limit meaningless.

Lawrence turned suddenly from trainer to trainee, and for four months she prepared for the sixth *Mir*-shuttle docking mission. She would replace astronaut Michael Foale and become the second American woman to live on *Mir*.

Then on June 25, a supply ship punched a hole in Lawrence's plans. The *Spektr* module of *Mir* was severely damaged when *Progress* smacked into the side of the space station. The damage crippled the craft and necessitated extensive work by cosmic mechanics.

When Russian and NASA flight directors determined that it would take many hours of space-walking to repair *Mir*, Lawrence was sold short again. She could fit into the shuttle and the *Soyuz*, but she could not safely fit into the bulky Russian Orlan spacesuit required for space walks.

Lawrence was replaced by David Wolf. Two months later, she rode along on the space shuttle *Atlantis* and helped Wolf through the hatch to destiny. A year later, she rode on *Discovery* as it picked up the last American inhabitant of *Mir*.

"There are no bad missions, so I'm not going to be picky," Lawrence noted. "There is still a mystique to being an astronaut. Not a lot of people get to go into space."

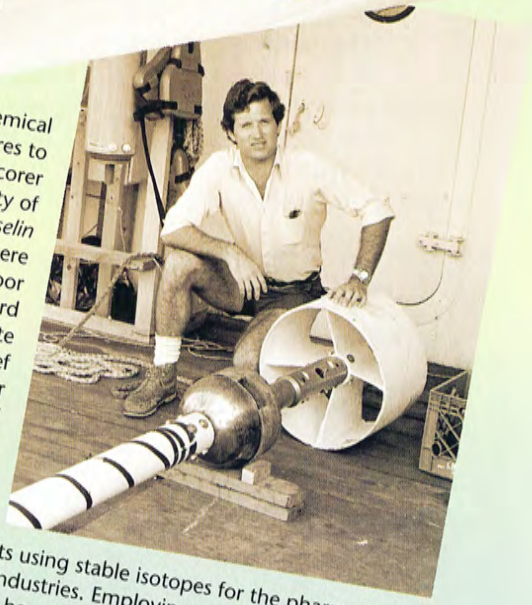
—*Mike Carlowicz*

NASA

Wendy Lawrence

MIT/WHOI Joint Program

Jean Nichols '75 (biological oceanography) is a founding principal at JNE & Associates Inc. in San Diego, an environmental consulting firm emphasizing coastal and wetlands projects.



John Jasper '88 (chemical oceanography) prepares to deploy a gravity corer aboard the University of Miami's R/V *Columbus Iselin* in the Panama Basin, where he collected seafloor samples to study the record of glacial-interglacial climate change. Jasper is now chief scientific officer of Molecular Isotope Technologies, LLC (www.MolecularIsotopes.com) in Niantic, Connecticut, where he is responsible for designing and producing processes and instruments using stable isotopes for the pharmaceutical and food science industries. Employing techniques developed in paleoceanographic studies, he has a patent pending on an isotopic product security technique ("fingerprinting") for application in these industries.

Andrew Jahn '76 (biological oceanography), right, and Peter Wiebe, then a young WHOI scientist, share a contemplative moment aboard R/V *Chain* in the early 1970s. Jahn is a scientist in the planning department of the Port of Oakland, where he works on wetlands and habitat restoration projects in San Francisco Bay. Wiebe, now a Senior Scientist in the Biology Department, holds the Adams Chair at WHOI.

'An Intellectual Adventure'

From the Black Hills to the Mid-Ocean Ridges

Brian Tucholke says he's "been a geologist from the time I first crawled off my baby blanket and grabbed a fistful of dirt."

He grew up in the Black Hills of South Dakota, which rise out of the continent to expose layer upon layer of rocks laid down over billions of years. It's a natural geological laboratory, and it was Tucholke's playground.

"Almost the entire layer cake of geologic history, from the Pleistocene to the Precambrian Era, is sitting right there," he said. "I spent a lot of time roaming around the Badlands hunting for fossils, finding minerals in abandoned mines in the Hills, hunting for native American artifacts, spelunking...."

Tucholke earned his B.S. degree at the South Dakota School of Mines & Technology. He graduated in 1968—just at the moment in scientific history when a new theory was revolutionizing our fundamental understanding of the earth. The theory, plate tectonics, explained how large sections of the earth's surface were created by magma upwelling at mid-ocean ridges and destroyed when portions of older seafloor descend back toward the mantle in deep oceanic trenches.

The scientific excitement spurred Tucholke to turn his geologic eye toward the oceanographic frontier, and he entered the inaugural class of the just-established MIT/WHOI Joint Program.

"I mostly gave up the bedrock stability of the western mountains for the rolling seas," he said. "MIT's academic reputation and the field research opportunities at WHOI seemed like the ideal combination." The village atmosphere of Woods Hole also tempered the culture shock of moving to Cambridge after his small-town boyhood in Hot Springs, South Dakota, population 2,300.

"It's a very satisfying process of assembling little clues to reconstruct large-scale events that happened over long time periods."

Brian Tucholke (right) examines a newly extracted seafloor sediment core aboard R/V *Knorr* in the early 1970s with his advisor, Charley Hollister (center), who was WHOI Dean of the Joint Program from 1979-89, and Ben Allen, now a Research Engineer at WHOI.

Tucholke focused his thesis work on the Greater Antilles Outer Ridge, a huge drift of seafloor sediments deposited by abyssal currents north of Puerto Rico.

"We hit the ridge with everything we could muster," he said. He placed current meters in strategic locations, collected water temperature and salinity data with Nansen bottles, filtered seawater to study suspended particles in the deep currents, and cored the seafloor to look at sedimentary strata. "We even built a deep-sea camera that pogoed across the bottom with a trip wire to photograph current markers on the muddy seafloor," he said.

With this smorgasbord of collected evidence, Tucholke could reconstruct how tectonic forces, abyssal ocean currents, and other factors combined to build and sculpt the ridge.

"It's a very satisfying process of assembling little clues to reconstruct large-scale events that happened over long time periods," Tucholke said. Having solved one relatively modest geologic puzzle in the Antilles, he just kept on going, using marine geological and geophysical tools to study all aspects of ocean-basin evolution from ancient rifting that created the first seam between continents to tectonics on modern mid-ocean ridges.

"It's been a self-propelling intellectual adventure," he said.

After graduating in 1973, he joined Leg 35 of the Deep Sea Drilling Project off Antarctica in 1974. There, he said, he helped "piece together the geological history of how the Drake Passage opened," as the tip of South America split from the Palmer Peninsula to provide a connection between the southern Pacific and Atlantic Oceans.

He then spent half a decade at the Lamont-Doherty Geological Observatory, drawn to its vast archives of untapped geophysical data collected in the 1950s and 1960s. But in 1979 he returned to WHOI, where he could combine a high level of intellectual stimulation with a less urban lifestyle. Along the way, he has mentored Joint Program students in

Tom Kleindinst

Brian Tucholke

subsequent generations and served as education coordinator in the Geology and Geophysics Department. In 1998 he was awarded the Henry Bryant Bigelow Chair at WHOI in recognition of his contributions to ocean sciences.

All told, Tucholke has logged 26 oceanographic cruises, including 15 as chief scientist, and in a humorous brief biography of himself, he wrote: "The mark of his passage can often be seen in the imprint of his cowboy boots, several decrepit pairs of which he has buried at sea in oceans ranging from the North Atlantic to the Bellingshausen Sea off Antarctica."

His research has revealed the evolution of the Atlantic Ocean, from the continental margin to the Mid-Atlantic Ridge, since it began to form 180 million years ago. Recently he discovered previously unknown mid-ocean ridge structures, dubbed megamullions, which seem to resemble corrugated mountainous domes formed in continental areas that are being extended by tectonic forces, such as the western US. The finding brings him full circle, fostering new "fruitful interactions with continental geologists and allowing me to pursue interests back in the heartland of my youth," he said.

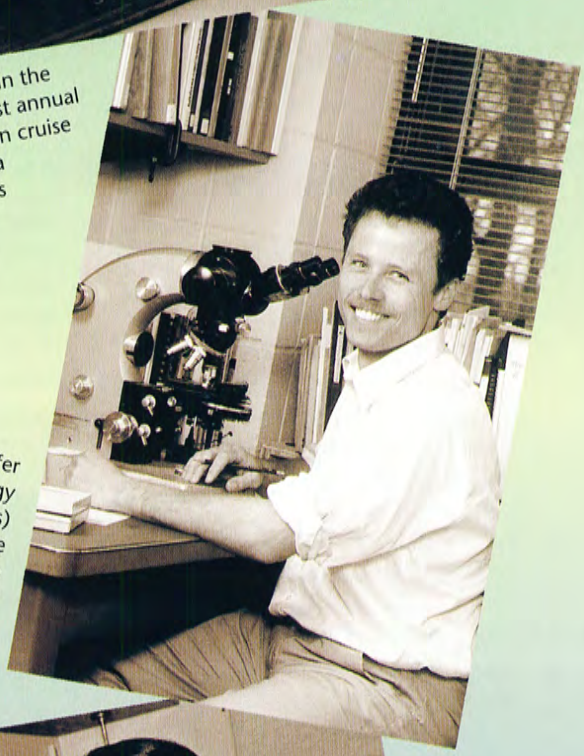
"I always wanted to establish a Rocky Mountain Institution of Oceanography," he said with a smile, "but it isn't practical."

Unfortunately, it will take many millions of years for tectonic forces in the western US to create an adequate harbor. "WHOI is the next best thing," he said.

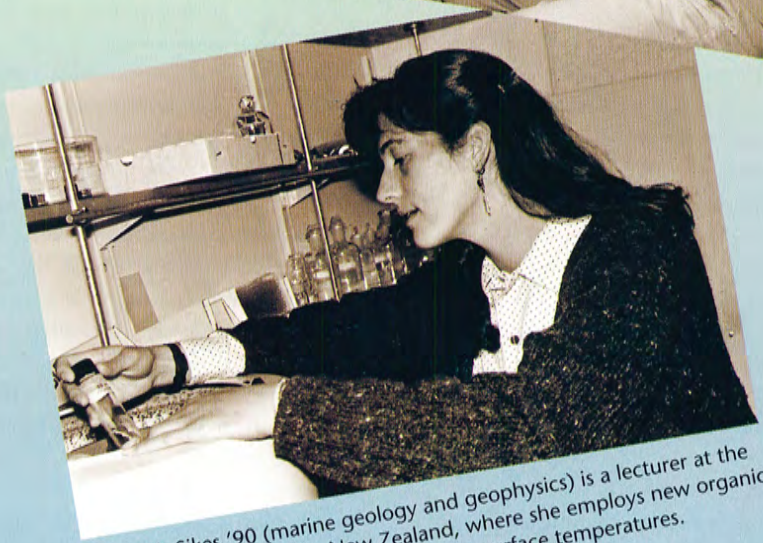
— Laurence Lippsett

MIT/WHOI Joint Program

Graduate students haul in the line to set sail on the first annual Joint Progam orientation cruise in 1990 aboard the Sea Education Association's brigantine *Westward*.



Thomas Ehrendorfer '93 (marine geology and geophysics) returned to his native Austria to become a researcher at Amt der Niederösterreichischen Landesregierung.



Elisabeth Sikes '90 (marine geology and geophysics) is a lecturer at the University of Auckland in New Zealand, where she employs new organic chemical techniques to estimate past sea surface temperatures.

WHOI Waypoints

Tom Kleindinst

WHOI's 1999 Annual Appeal surpassed all previous years. To all WHOI supporters, a sincere thank-you from the Development Office's senior staff (from left, Mary Evans, Jim Rakowski, Lesley Reilly, Dan Stuermer, Jane Bradford, and Jane Neumann, huddling on R/V Oceanus*' bow on a windy, wintry day). Please let us know of friends who might like to "come aboard."*

Calendar of 2000 Associates Events

- June 2 – Summer Science Supper: "Ocean Observatories"
- September (tentative) – Tour Research Vessel *Oceanus*

2001-2002 Expeditions for Associates

- Rain Forests and Reefs: Belize, Honduras, Nicaragua, Panama, and Costa Rica
- Circumnavigation of South Georgia & Falkland Islands
- The Galápagos Islands
- Treasures of Japan

We'd like to hear from you.

Contact us at: Woods Hole Oceanographic Institution, MS # 40, Woods Hole, MA 02543. Phone: 508-289-4895. Fax: 508-457-2167. E-mail: associates@whoi.edu. Web site: www.whoi.edu.

Alumnus Returns as Director of Development

Continued from back cover

nia, Santa Barbara, in 1970 and came to WHOI, where he did his dissertation research on *gelbstuf*, the dissolved organic matter in seawater—the oceanic equivalent of humus in soil. Gagosian was on his thesis committee, and Stuermer shared an office with a new postdoctoral student at the time named John Farrington, now WHOI's Dean of Graduate Studies.

"The office was so cramped, I'd have to tell John when I was going to stand up so he could scoot in to make room," Stuermer recalled.

His wife Betty, a graphic artist, worked in WHOI's engineering department. There she created art for publications and drew illustrations, for example, of the submersible *Alvin's* appendages for Scientist Emeritus Bob Ballard and Barrie Walden, now WHOI's Manager of Operational Science Services.

"We loved all our associations with people at WHOI and always had fond memories of the place," Stuermer said.

After graduating with a degree in chemical oceanography, Stuermer had a two-year postdoctoral fellowship at UCLA. He was a scientist from 1977 to 1983 at Lawrence Livermore National Laboratory, where he did research on coastal pollution and on groundwater pollution threats posed by the extraction of oil shales, a potential alternative fuel source.

Tom Kleindinst

Dan Stuermer

In 1977, Stuermer and his family pursued a dream and built a winery in northern California.

"I learned that producing good wine was only the first step," he said. "Selling wine depended as much on personal relationships with merchants and restaurateurs as on the wine quality."

The family sold the winery after a successful decade-long run, and Stuermer joined Thermo Electronic Corporation to run one of its analytical chemistry laboratories in northern California. By 1994, he was president of the company's subsidiary, Thermo Analytical, Inc., in Lancaster, Pennsylvania, with responsibilities for all aspects of laboratory operations, financial performance, marketing and sales efforts, and strategic planning.

When he began, the company's primary clients were federal agencies. But that market collapsed, and Stuermer spearheaded a major reorganization, transforming the company to seek and serve private-sector clients. Today Thermo Analytical is the leading commercial chemical and microbiological firm for the environmental and pharmaceutical industries. It has annual revenues of some $40 million and employs 650 scientists and support personnel.

His mission accomplished, Stuermer began to hear the call of the ocean again.

"The only waves in Lancaster were amber waves of grain," he quipped. That's when he began planning his sailing adventure and when Gagosian called. The two were well acquainted because Stuermer had become a WHOI Corporation member in 1993 and a Trustee in 1997.

"I was always inspired when I visited WHOI by seeing the excellent quality of the scientific work going on and its importance to the future of society," Stuermer said. He decided to settle for a shorter five-month adventure, sailing his 37-foot yawl from Annapolis to Bermuda, Nova Scotia, and Maine (including legs with his adventurous father and mother, both near 80 years old) before steering into Quissett Harbor last fall.

As Director of Development, Stuermer will be responsible for the Institution's fund-raising efforts, including planning and managing a multi-year, multi-million-dollar capital campaign.

"I wanted to make a difference by using my experience to advance WHOI's mission," he said.

A Fitting Gift for a Generous Genius

Just months after the Japanese bombed Pearl Harbor, Arnold Arons, a young Harvard graduate student, came to WHOI to take part in what soon became the Underwater Explosives Research Laboratory, under the direction of his advisor, E. Bright Wilson Jr.

"We couldn't do much in the way of explosives in Cambridge," Arons joked. But off the WHOI pier and out in Vineyard Sound, the group could fire experimental charges and even full-scale weapons. Their work clarified much of the then-little-known physics of explosion phenomena. They tested and optimized various experimental explosive compositions to guide the national manufacturing effort and aid the Navy in its anti-submarine warfare effort.

Henry Stommel

After the war, Arons returned to academia as a professor at Stevens Institute of Technology and later at Amherst College, but he returned in summers to do research at WHOI, from 1947 until 1968, when he moved to the University of Washington. At first he continued working on explosion shock wave propagation, but his Woods Hole office was next to a young scientist named Henry Stommel, who soon enticed Arons to pursue physical oceanography.

Stommel had also taken part in several WHOI wartime projects and developed an interest in oceanography. In 1948, Stommel solved the mystery of why great wind-driven ocean currents, such as the Gulf Stream in the Atlantic and the Kuroshio in the Pacific, have intense, narrow streams on their western sides and broad sluggish flows on their eastern sides. Through a simple and elegant mathematical analysis, he showed that this asymmetry was caused by the spherical shape of the rotating earth. This profound and seminal breakthrough launched the modern era of physical oceanography, as well as Stommel's long career as the century's most influential oceanographer.

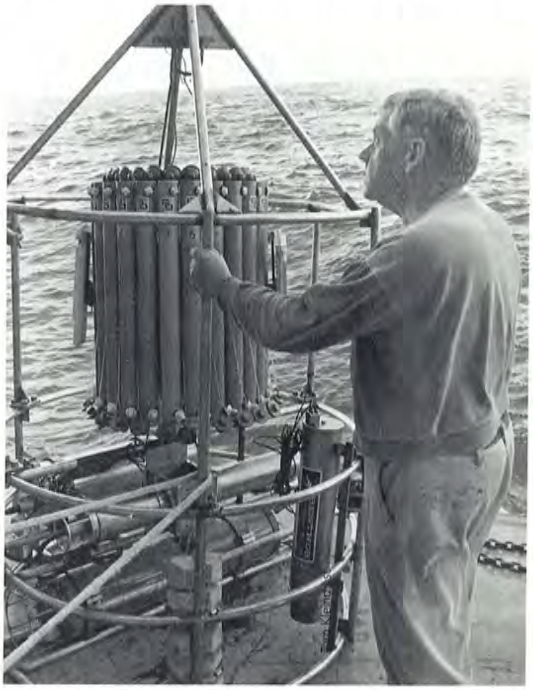
"Hank was an authentic genius," Arons said. "He was the deepest thinker and one of the most generous people I've ever encountered. He had so many ideas, he couldn't handle them all, and so he gave them to others."

Arons said that Stommel taught him oceanography, and the two collaborated on research. "We built a model of circulation of the abyssal ocean that we thought was too simple to hold up," Arons said, but decades later, their model remained the foundation for the World Ocean Circulation Experiment, the ongoing multi-national research effort to describe global ocean circulation.

"Throughout his career, Hank sought out people with great eagerness, inviting them to come to Woods Hole to talk oceanography and give colloquia, to bring new ideas and work out older ideas," Arons said. "Discourse and interaction were part and parcel of his being. He'd fire his ideas at people, get their reactions, pick up information, sharpen his own insights. This exchange of ideas would provide the cues to subjects and problems that he would later sit down and penetrate."

Tom Kleindinst

Arnold and Jean Arons established a charitable gift annuity with WHOI, which will create the Henry Stommel Visiting Scholars Program.



Stommel aboard *Oceanus* in 1980

Stommel died in 1992, and in his honor, Arons and his wife, Jean, have established a charitable gift annuity with WHOI. The Aronses will receive income from the gift for the rest of their lives and then the money will be used to create The Henry Stommel Visiting Scholars Program.

"In expression of gratitude and respect for one of the finest and most generous people I've ever met, I wanted to establish a scholarship program that reflected what he valued and how he operated," said Arons, now Professor Emeritus at the University of Washington and a WHOI Honorary Trustee and Corporation Member. The program will allow junior scientists at WHOI to invite visiting scholars to campus—much the way Stommel used to do.

"Young scientists will be able pick somebody from the outside that they want to be with, somebody at whose feet they would like to sit for a time, and talk with and chew problems over with," Arons said.

The program, he hopes, will stimulate just the sort of scientific discourse—and occasional breakthroughs—that invigorated Henry Stommel, as well as the entire field of oceanography.

The Call of the Ocean

Stuermer takes the helm As Director of Development

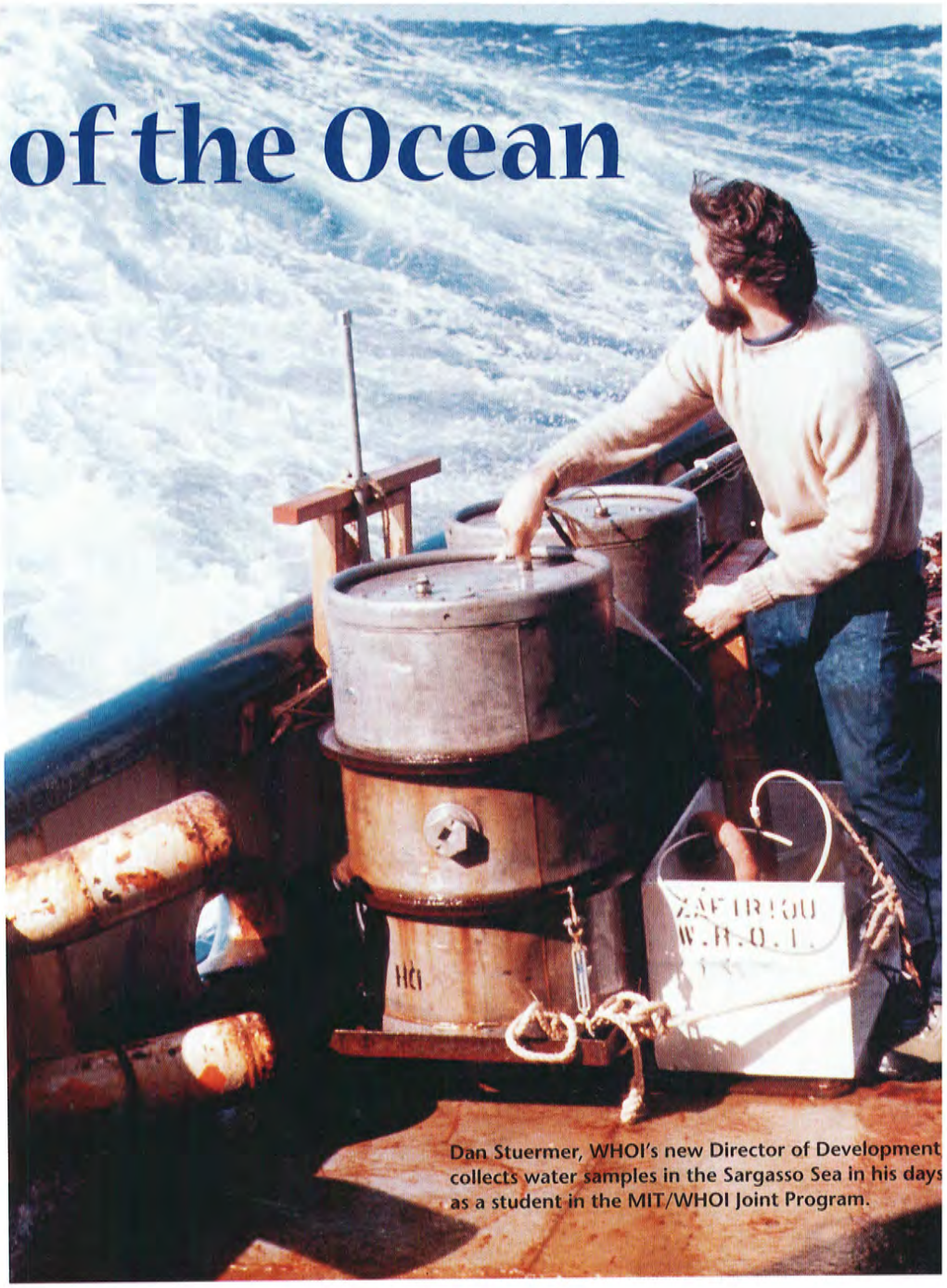
Dan Stuermer's career changed course a few times since he earned his Ph.D. degree from the MIT/WHOI Joint Program in 1975. A successful research scientist, winery owner, and corporate president, he was looking for a new challenge last year—one that included his lifelong passion for the ocean.

"I was planning a two-year sailing adventure that would bring my wife Betty and me back to California from the East Coast via the Caribbean and Hawaii," he said. "I'd already bought all the cruise guides and charts, and, in fact, I was reading the guide describing the transit through the Panama Canal when (WHOI Director) Bob Gagosian called and asked me to come back to WHOI."

Changing course again, Stuermer became WHOI's new Director of Development. In Stuermer, Gagosian saw someone whose multi-faceted experience in science, marketing, and management made him well suited for the job. In addition, Stuermer was personally acquainted with WHOI's significant impact on oceanography and oceanography's significant impact on society.

Growing up in southern California, Stuermer started surfing and sailing at age 12. He received his B.A. degree in chemistry from the University of Califor-

Continued on page 14



Dan Stuermer, WHOI's new Director of Development collects water samples in the Sargasso Sea in his days as a student in the MIT/WHOI Joint Program.

WOODS HOLE OCEANOGRAPHIC INSTITUTION 1930

WOODS HOLE Currents

Woods Hole Oceanographic Institution
Woods Hole MA, 02543

Non-Profit Organization
U.S. Postage Paid
Permit No. 46
Woods Hole, MA 02543

Currents is published quarterly by the Woods Hole Oceanographic Institution for WHOI Associates and friends.
www.whoi.edu