



Institution ships and village laboratories are in the foreground of this aerial view of Woods Hole. Additional facilities are located on the Quissett campus a mile and a half away.

THE Woods Hole Oceanographic Institution is a private, nonprofit research facility dedicated to the study of all aspects of marine science and to the education of marine scientists. With staff and students numbering about 1,000, it is the largest independent oceanographic research institution in the nation. The 60-year-old Institution is organized into five scientific departments: Applied Ocean Physics and Engineering, Biology, Chemistry, Geology and Geophysics, and Physical Oceanography. Cross-disciplinary work is conducted within the departments and also under the auspices of the Center for Marine Exploration, the Coastal Research Center, and the Marine Policy Center, where social scientists work on legal and policy problems associated with human use of the oceans. More than 350 research projects are underway at the Institution at any given time. About 125 students are enrolled in the Oceanographic's joint graduate program with the Massachusetts Institute of Technology, and Postdoctoral Fellow, Summer Student Fellow, and other education programs are also offered. The Institution's research fleet includes the 279-foot *Knorr*, 210-foot *Atlantis II*, 177-foot *Oceanus*, 65-foot *Eagle Mar*, 46-foot coastal vessel *Asterias*, the three-person submersible *Alvin* capable of diving to 13,000 feet, several small boats, and remotely operated deep submergence vehicles such as *Argo* and *Medea/Jason*.

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Cover Photo: A new shallow water conductivity/temperature/depth and rosette sampler unit was at work during a July biology cruise to the Sargasso Sea aboard R/V *Oceanus*. Tracy Villareal draws a water sample.

Photo by Frederica Valois.

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Director's Comments

ALTHOUGH Woods Hole Oceanographic Institution is a private, independent institution engaged in basic research and education, both our daily activities and our long term health are inextricably linked to trends in the federal government and society as a whole. These links provide both opportunities and challenges for the WHOI community, as we saw only too clearly in 1990.

Early in the year, as the United States watched the revolutionary changes in the Soviet Union and in our relationship to the USSR, we anticipated a growth in opportunities for ocean science. We not only capitalized on the new openness by establishing much closer ties with Soviet colleagues; we also actually saw the beginning of an evolution in the definition of national security—no longer need it mean simply a strong military defense. The new world of lessened super power tensions portended increased concern with environmental conditions, education, and economic competitiveness as coequal aspects of our security and health as a nation.

Because the ocean plays such a critical role in these concepts, the change in in-

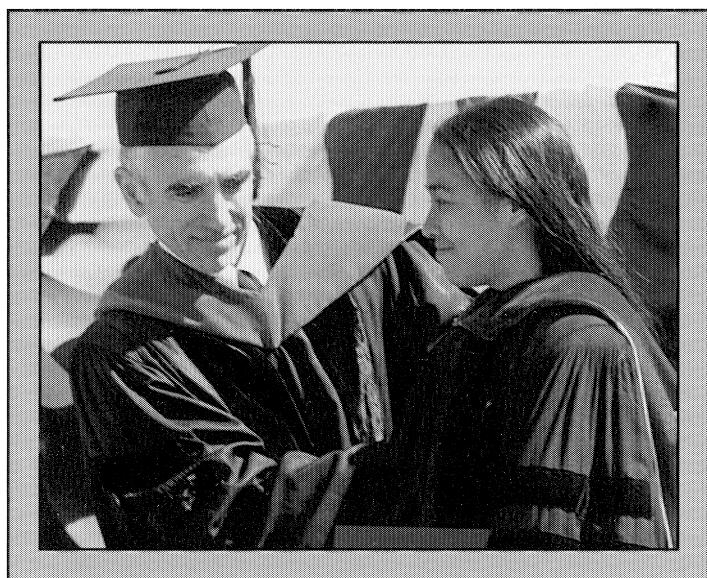
ternational relations put ocean science in the spotlight and opened new opportunities for our science, engineering, policy, and educational programs. Also, on the federal level, novel forms of interagency cooperation in funding programs related to global change emerged. Support for ocean science remained strong at our traditional sponsors (ONR and NSF), and increased at other mission agencies, such as NOAA, DOE, and EPA.

As the year progressed, however, with war threatening in the Middle East, uncertainties in oil prices, and federal budgets (and the overall Congressional budget process) reshaped in response to deficits, our optimism was challenged. While the national and world need for our science and education remains clear, and the FY 91 budget includes significant increases for our field, the long term prognosis has become much more problematic. Nevertheless, our long range planning process remains founded on the conviction that the nation, and the world, will increasingly need the product of our research and education.

To meet these challenges in 1990, we constituted a number of committees to examine our strengths and weaknesses. At a retreat in May we reviewed our heritage and strategies, rewrote our mission statement, and decided on two major initiatives—air sea interaction and instrumentation—that we believe will enhance our abil-

ity to continue to play a leading role in the field. And we have increased our activities on local, state, and national levels to ensure that our capabilities and views are known throughout the ocean science community, and by the leaders and policymakers who influence it.

On a more local level, 1990 saw both major successes and some problems. The addition to Clark Laboratory was completed and occupied, and the new National Ocean Sciences Accelerator Mass Spectrometer arrived in McLean and successfully completed its final tests. Our new Associate Director for Education and WHOI Dean of the Joint



David Gray

Director Craig Dorman adjusts Joint Program graduate Laura Kong's hood during commencement ceremonies on the WHOI pier in June.



Program, John Farrington, stepped into his duties at full steam; and Dick Pittenger, former Oceanographer of the Navy, joined us as Arctic Coordinator. Most importantly on the plus side, our science and technology projects—documented in companion reports—remained strong and there is no lack of good, exciting questions being asked about the oceans. If anything, the fun and challenge of our resources at WHOI are increasing.

Less positive is the fact that the *Knorr* refit remains uncompleted. We had contracted for the ship to be delivered in February. As the year wore on, it became apparent she would not get out of the yard until mid 1991. In addition to the direct headaches of this

year. With lots of effort by all, we made this target, although cuts in our base, reductions in other income (like interest), and record high requirements for Institution support of our scientists combined to leave us with little to carry forward at year's end, as our balance sheets—still positive though not as healthy as we'd like—attest.

Recognizing the combinations of global and national changes, the growing importance of our work, and the continuous difficulties with federal funding, we also committed in 1990 to improving our external affairs and outreach activities. In order to increase our visibility and more clearly articulate our message, the communications function was reorganized and

strengthened. In order to increase funding from private individuals, corporations, and foundations, we developed new systems and mechanisms for fund-raising, and we started planning for a major campaign. All these pro-

cesses take time to build, but we are already seeing positive results.

The form of this report is the result of one recommendation from the communications staff. In order to target our many audiences more effectively, we

are breaking apart the annual report as it has been produced in the last several years. This document, our official report, will be widely circulated within the Oceanographic community—to scientists and staff, Trustees and Corporation Members. A new publication, *Reports on Research*, to be produced twice a year, will share the results of our science, engineering, and policy research with many members of our audience. And a separate *Report To Donors* will highlight those individuals, corporations, foundations, and other groups who have contributed to WHOI in 1990, giving greater recognition to the critical support they provide and expressing our appreciation.

As a result of our retreat and its recommendations, new international relationships, new science initiatives, strengthened administrative programs, and the continuing high quality research conducted by our science, engineering, technical, and policy staff members, I believe the Oceanographic is well positioned to succeed in the 1990s. We will continue to be challenged by our needs as a "soft money" institution, but our intellectual and organizational abilities make us stronger than ever to meet those challenges.

Craig E. Dorman
Director



Clark Laboratory additions were completed in 1990 to house portions of the Physical Oceanography and Geology & Geophysics departments as well as a Student Center.

project, we had planned our overhead budgets based on six months of *Knorr* operations. The reduction in income made us rebudget at 97 percent of initial plans some six months into the



WHOI Ashore & Afloat

SEVERAL hundred employees, Associates, and guests attended a gala reception January 22 in Clark 507 to kick off the Institution's 60th anniversary celebration. Blue and white balloons and historic photo displays added to the festive atmosphere. Director Craig Dorman offered a toast to WHOI's past and future successes and reiterated the principles upon which the Institution was founded. Special 60th anniversary events during the summer included Joint Program commencement ceremonies on the WHOI pier and four symposia on the health of the oceans, global climate change, and, in an August "cool-off" set, WHOI in the Arctic and WHOI in the Antarctic.

Work was underway through spring to complete the Clark Laboratory additions (now known as Clark South), and the first occupants moved in late in May. Funds donated in memory of Trustees Joseph V. McKee and James Shepley provided for a ball field and other staff recreational facilities behind Clark, to be ready for use in 1991. Twelve housing units, the first built by the Institution on the Quissett Campus, were completed at 85 Oyster Pond Road and dedicated to the late Carolyn B. Miller, who served as housing coordinator for many years. The Co-op Building at 93 Water Street, home of

the Public Information Office, celebrated the completion of a major renovation with a June open house for Institution staff. An open meeting to update employees and the local community on WHOI's long-term campus improvement plans was held in September in Redfield Auditorium. Lane, Frenchmen and Associates, Inc. of Boston is working with the Institution to review physical facilities and update the master plan.

Associate Scientist Ellen Druffel received one of the 1990 James B. Macelwane Medals from the American Geophysical Union in recognition of her "significant contributions to the geophysical sciences as a young scientist of outstanding ability." Joint Program alumnus William Young, now at Scripps, also received a Macelwane Medal. Assistant Scientist Edward DeLong received a Young Investigator Award from the Office of Naval Research. Assistant Social Scientist Andrew Solow received the President's Prize from the International Association for Mathematical Geology for "an original and outstanding contribution to the application of mathematics to the geological sciences through publication." Senior Scientist Nicholas Fofonoff received the American Geophysical Union's Ocean Science Award for "his contributions to the development and usage of modern oceanographic instrumentation." Senior Scientist Holger Jannasch, who spent two months presenting lectures

throughout Australia, was chosen 1990 Rubbo Orator by the Australian Society for Microbiology. Sea Grant Coordinator and Senior Scientist David Ross was elected a member-at-large of the American Association for the Advancement of Science. Trustee Mildred Dresselhaus and Honorary Trustee Roger Revelle were among 20 scientists awarded the President's 1990 National Medal of Science.

aluminum boat *Mytilus* was christened by Cynthia Dorman during Annual Meeting festivities in June.

More than 30 scientific and management staff members gathered in May at the Ocean Edge Confer-



Tony Kleindinst

The 65-foot wooden yacht *Eagle Mar* was donated to the Institution by Edward W. Scripps II and his wife Betty. Their gift also provides for two years of dockside maintenance and repair. *Eagle Mar* was built in Europe in the 1970s and served as Scripps's office and mobile communications center in recent years. The yacht will be used primarily for research and education. The Coastal Research Center's new 24-foot

Employees, Associates, town and state officials, and other friends of the Institution gathered in Clark 507 on January 22 to kick off the Oceanographic's 60th anniversary celebration.

ence Center in Brewster, Massachusetts, to discuss internal management, science strategy for the next ten years, and marketing the Institution. The agenda focused on creating an institution mission statement and examining several internal studies and initiatives so that complementary internal and external Institu-



tional strategies could be created.

Several new management appointments were made in 1990. John Farrington returned to the Institution after a three-year hiatus teaching at the University of Massachusetts, Boston, to assume the expanded duties of Associate Director for Education and Dean of Graduate Studies. Senior Scientist G. Michael Purdy was appointed chairman of the Geology and Geophysics Department succeeding David Ross, and Senior Scientist James Luyten became chairman of the Physical Oceanography Department succeeding Robert Beardsley. David Gallo, formerly with the Center for Marine Exploration, assumed the duties of Coordinator of Industrial and International

Programs upon the departure of Paul Dudley Hart. Gallo will assess the needs of industry and match them with Institution resources. Promoting WHOI's reputation for excellence is the goal of Sallie Riggs, who filled the newly created position of Director of Communications in August.

Former Oceanographer of the Navy Richard Pittenger became the Institution's first Arctic Research Coordinator in November.

Robert Groman was appointed Manager of the Information Processing and Communications Laboratory succeeding William Little, who returned to the technical staff. Graphic Services Manager Vicky Cullen was promoted to Manager of Publications and Graphic Services. She was also named editor of *Oceanus* magazine, succeeding Paul Ryan, who resigned after 14 years of service to assume an editorial position at the Institute for Scientific Information in Philadelphia.

The Development Office staff added a number of new faces in 1990, including



Dorsey Milot, who succeeded Nan Weiss as director of the Associates Program. Weiss moved to North Carolina but remains on the development staff working on special projects. New Development Officer Robin Good oversees information services, research, and computer systems.

Senior Scientist John Milliman began a one-year rotating appointment in August at the National Science Foundation (NSF) in Washington as an associate program manager for NSF's marine geology and geophysics program. Associate Scientist William Curry returned to WHOI after a two-year NSF appointment as associate director of the Climate Dynamics Program.

The new Staff Training and Development Advisory Committee was instrumental in implementing a series of workshops on management skills (better known as "Management 101") for In-

stitution supervisors beginning in November.

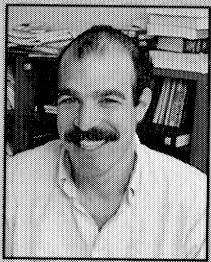
Director Craig Dorman spent three weeks in May in the Soviet Union to investigate opportunities for WHOI to share technology with Soviet scientists while taking advantage of their large facilities and fleets. Along with Senior Scientist Terrence Joyce of the Physical Oceanography Department, he participated in lectures and discussions at 22 research institutions.

Marine Policy Center (MPC) Director James Broadus led a nine-member U.S. delegation of policy experts to Moscow in May for a bilateral meeting on worldwide strategies for assurance against environmental threats to the world's oceans. MPC is leading a two-year U.S.-Soviet program of professional exchanges and collaborative research. Broadus also visited the Korea Ocean Research and Development Institutue (KORDI) in No-

Photos by Tom Kleindinst



WHOI Award winners for 1990 included, clockwise from upper left, Ed DeLong, Ellen Druffel, Nick Fofonoff, and Andy Solow.





vember for the first in a series of workshops that are part of a "sister institution" cooperative agreement between WHOI and KORDI signed in July.

Dartmouth College Professor of Engineering Dan Lynch received the 1990 Bostwick H. Ketchum Award for his mathematical capabilities and interest in their application. Lynch presented a lecture on "The Computer Revolution and Ocean Sciences," discussing the various types of computer models and how they can be used to solve scientific problems.

Water Baby: The Story of Alvin, written by Science Writer Victoria Kaharl, was published in late September by Oxford University Press. The book offers a personal side to the submersible's quarter-century of service to the marine science community. DSV *Alvin* Pilot Cindy Lee Van Dover, who is also a Joint Program graduate, became one of the first Americans to pilot a Soviet submarine during a three-week cruise in October off the West Coast. Van Dover made four dives in the MIR, two as a copilot and two as a scientist. In December, Van Dover participated in the first all-female *Alvin* dive along with Cynthia Huggett and Elana Leithold of North Carolina State University. They explored Fieberling Guyot, an underwater mountain about 500 miles west of San Diego.

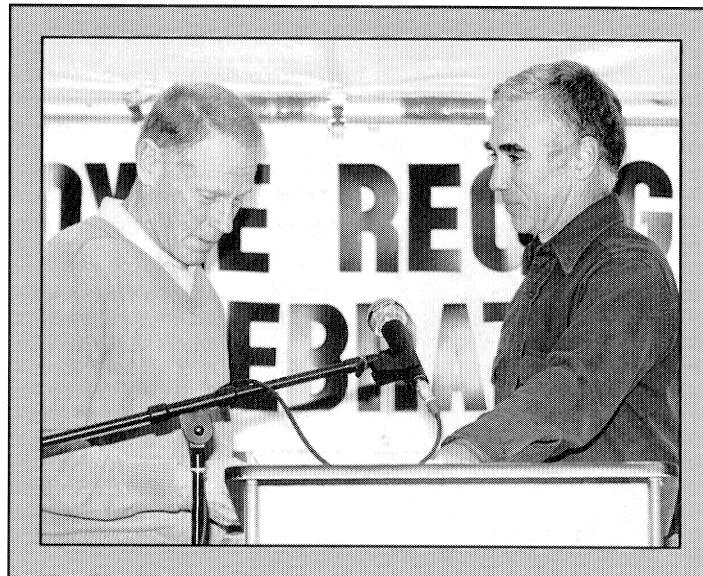
Some 30 employees with more than 10, 20, and 30 years of service to the Institution were honored October 3 at the second annual Employee Recognition Celebration under a tent behind Feno House. Dick

Edwards received the \$2,500 Vetlesen Award for his tireless efforts at the dock through the years. The Proposal Pushers, better known as the staffs of Sponsored Programs and Reproduction, received the \$5,000

Judith Fenwick, G. Richard Harbison, and Christopher von Alt. Joint Program students provided displays on their research efforts on the Feno House lawn at lunch.

The 1990 JASON Project and the creation of the Jason

Tom Kleindinst



Dick Edwards receives the Vetlesen Award from Director Craig Dorman at the second annual Employee Recognition Ceremony. Sponsored Programs and Reproduction Services were also honored.

Penzance Award for their efforts in preparing proposals to funding agencies.

The year's Associates activities included an April Boston Dinner that featured Antarctic research presentations by Biologists Brian Howes and Dale Goehring and Chemist Mark Kurz. About 60 new members attended New Associates day in May, and some 340 attended the annual October Day of Science when research presentations were given by Robert Weller,

Foundation for Education were formally announced early in 1990. Senior Scientist Robert Ballard established the foundation to continue his efforts to excite and motivate students in grades 4 through 12 in sci-

ence, math, and technology. Ballard, Director Craig Dorman, and Chairman of the Board Guy Nichols are members of the Foundation's Board of Directors. More than 250,000 students participated in the JASON Project at 14 North American sites, including Redfield Auditorium, during the project's April 30-May 12 satellite transmissions from Lake Ontario. Using the remotely operated vehicles *Jason* and *Medea*, Ballard and members of the Deep Submergence Laboratory explored the sunken 1812 war-

At the June christening of the Coastal Research Center's new boat, *Mytilus*, Maggie Rioux and Michael Moore congratulate one another as joint winners of the contest to name the boat. (*Mytilus* is a genus name for the blue mussel.) Pam Barrows and Bruce Tripp are at left and right.

Terri Cobelt





On *Alvin*'s first all-female dive Pilot Cindy Van Dover, right, took Elana Leithold, center, and Cynthia Huggett of North Carolina State University to Fieberling Guyot in the Pacific.

ships *Hamilton* and *Scourge* six miles offshore from Hamilton, Ontario, in 300 feet of water. A new feature this year allowed students at some broadcast sites to drive *Jason* remotely. Two of thirty-four Junior Argonauts who observed expedition operations in Canada were sponsored by WHOI.

Ballard received several awards in 1990 for his education efforts. These included the American Association for the Advancement of Science-Westing-

house Award for Public Understanding of Science and Technology, the American Academy of Achievement's Golden Plate Award, the William Procter Prize for Scientific Achievement from Sigma Xi, and the 1990

ference on digital data bases for electronic maps and charts. Soviet and American merchant marine cadets visited WHOI during a five-day August port call at Massachusetts Maritime Academy. The cadets were part of the first joint US/USSR maritime training cruise aboard the 365-foot square rigger *Druzhba*. The Massachusetts Marine Educators association held its 14th annual marine science conference at WHOI in April. More than 200 attended to hear presentations by WHOI staff members David Aubrey, Alan White, and Tundi Agardy. Nancy Green of the Public Information Office and David Ross of the Sea Grant Program were recognized for their contributions to the educators' organization.

More than 32,000 people visited the Exhibit Center in 1990. Expanded hours of operation lengthened the season to six months of full-time operation plus weekends and special holiday hours in November and December. Many media representatives

American Geological Institute Member Society Council's Award for Outstanding Contribution to the Public Understanding of Geology.

Among the many 1990 Institution visitors were Raphael Vartanov of the USSR Academy of Sciences, Indonesian Minister of State for Research and Technology Bacharuddin Jusuf Habibie, and Isao Uchida, president of the Japan Marine Science and Technology Center (JAMSTEC), who explored possibilities for increasing cooperative research efforts between JAMSTEC and WHOI.

Twenty-five members of the U.S. Arctic Research Commission met in Woods Hole in April to discuss defense, environmental research, and international relations. The Marine Policy Center sponsored an October con-

visited during the year, including the MIT Knight Science Journalism Fellows for a September day of informal research presentations and tours. Associated Press offered a major 60th anniversary story to newspapers nationwide.

Ellen Knebel, a sophomore at Falmouth High School, received the Institution's \$1,500 college scholarship for a chemistry project, "Lead Concentration in Swamp Sediments," entered in the 12th annual Falmouth Community Science Fair. Coastal Research Center Director David Aubrey was the keynote speaker for the Falmouth Academy Science Fair. "Oceans Alive: Plain Talk on Current Topics in Marine Science Presented for the General Public" attracted large crowds to Redfield Auditorium in March and April. The series of lectures was sponsored by the Sea Grant program.

Ken Stewart introduces a delegation from the Japan Marine Science and Technology Center to his work with deep-sea imaging technology. Sus Honjo stands at far right.



David Gray



Dean's Comments

I AM very pleased to be writing my first report as Associate Director for Education and Dean of Graduate Studies. Before I arrived on August 1, Director Craig Dorman served as an energetic and enthusiastic Acting Dean. Associate Dean Jake Peirson, assisted by the Education Office staff, provided the other portion of the "extra effort" required in the absence of a full-time Dean. Their combined efforts insured another year of success for Education activities.

Here are some highlights of the year:

- A Joint Program commencement ceremony was held on the Iselin Marine Facility pier as part of the Institution's 60th anniversary celebration. Commencement Speaker John A. Knauss, Under Secretary of Commerce for Oceans and Atmosphere and Administrator of the National Oceanic and Atmospheric Administration, provided insightful, often humorous, comments on the early days of WHOI and discussed the challenges of the rapid evolution of research in oceanography and oceanographic engineering. WHOI Corporation President John Steele and MIT Corporation Chairman David Saxon conferred thirteen Ph.D.s, three Degrees of Ocean Engineer, one Degree of Electrical Engineer, and five Master of Science degrees. Craig Dorman and Frank Perkins, MIT Dean of Graduate

Studies, hooded the doctoral graduates. Joint Program alumni, WHOI faculty, Trustees, and Corporation Members formed the academic procession, and the day closed with an evening reception, dinner, and dancing under tents on the Iselin mall.

- Most incoming Joint Program students participated in the first oceanographic orientation cruise on the Sea Education Association brigantine *Westward* in June. They gained first-hand, sea-going research experience (and several were introduced to the common sea-going affliction, *mal de mer*). The cruise was a resounding success and is planned as a yearly event for the incoming class.

- A Trustee Education Committee convened in December to provide advice and recommendations to our education program. The members of the new committee are listed at right on this page.

- Construction of the Joint Program Student Center on the upper level of Clark South was completed for use beginning in 1991 as a much needed gathering place and focal point for student social and organizational meetings.

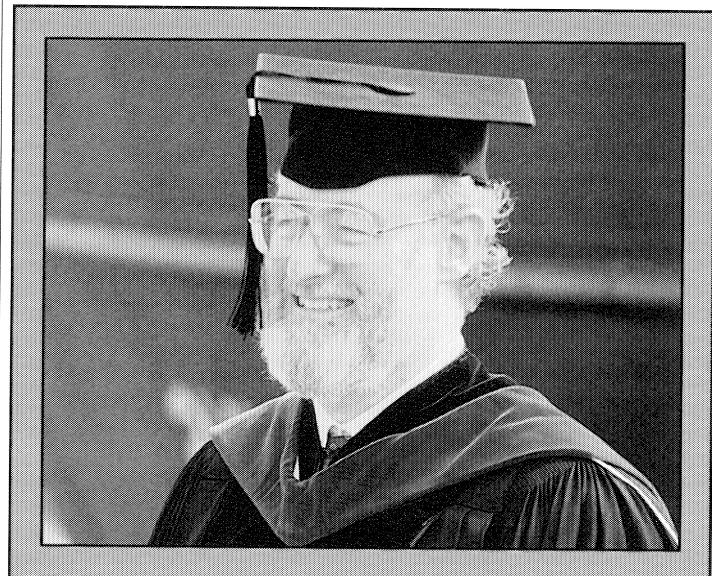
- In cooperation with MIT Joint Program Director Sallie Chisholm, we completed plans to allow MIT undergraduate students to work with WHOI scientists and engineers under the MIT Undergraduate Research Opportunities Program.

- The summer program in Geophysical Fluid Dynamics completed its thirty-second consecutive summer this year under the able direction of Rick Salmon of the Scripps Institution of Oceanography. Investigation by this year's 42 participants was significantly aided by the acquisition of new computing facilities, thanks to a grant from the Andrew W. Mellon Foundation.

- Our Summer Student Fellowship program, also in its thirty-second year of formal operation, provided 31 undergraduates with hands-on research experience as each student developed, carried out, and reported on a research project under the tutelage of a scientific staff member. This program continues to attract some of the

Trustee Education Committee

Lilli S. Hornig, Chair
Arnold B. Arons
Lewis M. Branscomb
Joel P. Davis
Mildred S. Dresselhaus
Evelyn E. Handler
Karen Lloyd
Henry A. Morss, Jr.
John E. Sawyer
Cecily Cannan Selby
Robert M. Solow
Keith S. Thomson



country's brightest undergraduates in science, math, and engineering—past Summer Student Fellows are frequent winners of the most coveted national graduate fellowships.

John Farrington was appointed Dean of Graduate Studies and Associate Director for Education in 1990.



In the light of continuing national concern for the poor state of science and mathematics education in the United States, especially in kindergarten through 12th grades, we are reviewing our potential to help improve the situation without negatively impacting existing programs. The Institution has been host over the years to numerous school groups and youth groups, as well as teachers' organizations. In one of our outreach efforts, during the

summer of 1990, six Utah State University Upward Bound students, mostly from the Utah-Arizona Navaho Indian reservation, spent a month in Woods Hole working in laboratories and participating in seminars, lectures, and field trips under the direction of Research Specialist George Hampson of the Biology Department.

On the local level, the Institution participated along with other science, engineering, and education organizations, the Falmouth school system, and Falmouth Academy in formally establishing the Woods Hole Science and Technology Education Partnership (WHSTEP). Its objective is "to promote, support and expand scientific literacy and opportunities

1990 Enrollment

Postdoctoral Scholar Awardees	11
Marine Policy and Ocean Management Fellows	7
MIT/WHOI Joint Program – Fall 1990	126
Summer Geophysical Fluid Dynamics Fellows	9
Summer Student Fellows	31
Guest Students	36
Minority Trainees	2

Graduate Degrees Awarded

	1990	1968-90
WHOI	Ph.D. 0	3
MIT/WHOI	Ph. D. 16	218
MIT/WHOI	Sc.D. 0	25
MIT/WHOI	Engineers 5	35
MIT/WHOI	Masters 6	23
	27	304

Total Degree Recipients*

*Some receive more than one degree

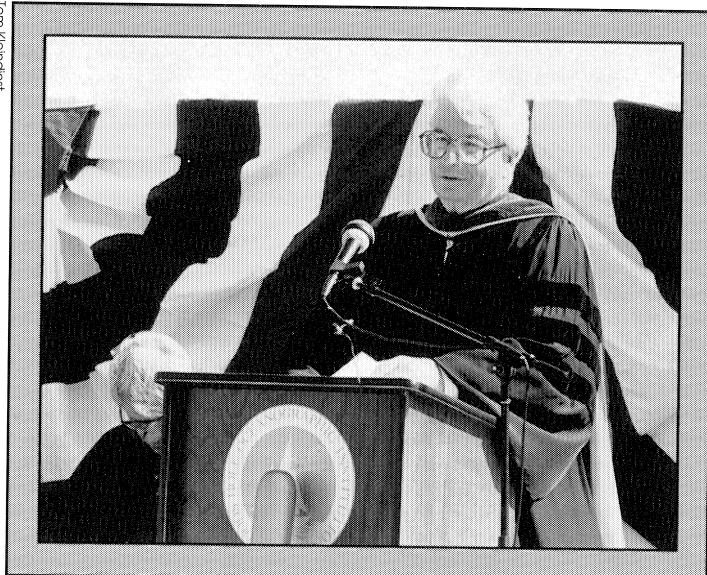
STEP, and a number of Institution people are participating. It is encouraging to see the community spirit of Woods Hole scientists and engineers and Falmouth educators, parents, and citizens in this joint venture. We are working with others to establish a similar network for southeastern Massachusetts.

In addition, we continue our involvement as a member of the Jason Foundation for Education Primary Interactive Site Network and look forward to the December 1991 expedition to the Galapagos Islands. We will assist the Jason Foundation expedition team, led by Senior Scientist Robert Ballard, as they once again bring the excitement of research and discovery to fourth through twelfth grade students via real time telepresence from sites in the Galapagos Islands.

I have been impressed during my first few months as Associate Director for Education and Dean with the dedication and quality of effort WHOI staff bring to bear on our education activities. Their work on the many committees required to maintain a high-quality program forms the backbone of our education efforts. In particular, the Education Coordinators of each of the WHOI departments deserve special recognition. It has been my pleasure to work with them and with our excellent, enthusiastic students and postdoctoral scholars, and I eagerly anticipate our future activities in education.

John Farrington
Associate Director for
Education and Dean of
Graduate Studies

Tom Kerec/WHOI



The 1990 commencement speaker was John Knauss, Under Secretary of Commerce for Oceans and Atmosphere and Administrator of the National Oceanic and Atmospheric Administration.

in science and technology education for all students in area schools by developing an effective partnership that draws upon the unique community resources available in Woods Hole and Falmouth." Jake Peirson serves as vice president of WH-



1990 Degree Recipients

Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program in Oceanography/Oceanographic Engineering

Doctor of Philosophy

E. Virginia Armbrust
B.A. Stanford University
Special Field: Biological Oceanography
Dissertation: Control of Gametogenesis in the Marine Centric Diatom *Thalassiosira weissflogii*

Erik T. Brown
B.A. Princeton University
Special Field: Chemical Oceanography
Dissertation: The Geochemistry of Beryllium Isotopes: Applications in Geochemistry

Paula G. Coble
B.A. Mount Holyoke College
M.S. University of Delaware
Special Field: Chemical Oceanography
Dissertation: Marine Bacteria as a Source of Dissolved Fluorescence in the Oceans

Daniel T. Cobra
B.S.E.E. University of Brasilia
Special Field: Oceanographic Engineering
Dissertation: Estimation and Correction of Geometric Distortions in Side-Scan Sonar Images

Noellette M. Conway
B.A. Trinity College
Special Field: Biological Oceanography
Dissertation: The Nutritional Role of Endosymbiotic Bacteria in Animal-Bacteria Symbioses: *Solemya velum*, a Case Study

Peter J.S. Franks
B.Sc. Queens University
M.Sc. Dalhousie University
Special Field: Biological Oceanography
Dissertation: Dinoflagellate Blooms and Physical Systems in the Gulf of Maine

John A. Goff
B.S. Brown University
S.M. Massachusetts Institute of Technology
Special Field: Marine Geology and Geophysics
Dissertation: Stochastic Modeling of Seafloor Morphology

Andrew T. Jessup
B.S.E.E. University of Michigan
Special Field: Oceanographic Engineering
Dissertation: Detection and Characterization of Deep Water Wave Breaking Using Moderate Incidence Angle Microwave Backscatter from the Sea Surface

Kevin T. M. Johnson
B.S. Pennsylvania State University
M.S. University of Hawaii
Special Field: Marine Geology and Geophysics
Dissertation: Trace Element Geochemistry of Oceanic Peridotites and Silicate Melt Inclusions: Implications for Mantle Melting and Ocean Ridge Magmagenesis

Laura S. L. Kong
B.Sc. Brown University
Special Field: Marine Geology and Geophysics
Dissertation: Variations in Structure and Tectonics along the Mid-Atlantic Ridge, 23°N and 26°N

David W. Lea
B.S. Harvard University
Special Field: Chemical Oceanography
Dissertation: Foraminiferal and Coralline Barium as Paleoceanographic Tracers

Joint program graduates in the classes of 1989 and 1990 enjoy commencement ceremonies on the WHOI pier in June.

Alan J. Lewitus
B.A. Rutgers University
M.S. Moss Landing Marine Laboratory
Special Field: Biological Oceanography
Dissertation: Physiology of Phototrophy and Heterotrophy in Algae with Contrasting Nutritional Characteristics, *Pyrenomonas salina* (Cryptophyceae) and *Poterioochromonas malhamensis* (Chrysophyceae)

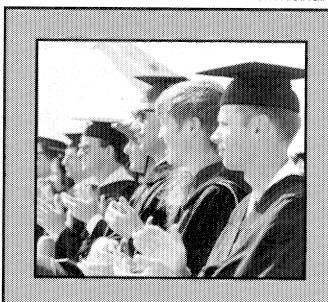
Mark A. McCaffrey
B.A. Harvard University
Special Field: Chemical Oceanography
Dissertation: Sedimentary Lipids as Indicators of Depositional Conditions in the Coastal Peruvian Upwelling Regime

Hagen Schempf
B.E. Stevens Technical Institute
Special Field: Oceanographic Engineering
Dissertation: Basin-Scale Tidal Measurements Using Acoustic Tomography

Bruce E. Miller
B.S. United States Naval Academy
Special Field: Oceanographic Engineering
Dissertation: Observation and Inversion of Seismo-Acoustic Waves in a Complex Arctic Ice Environment

Randall G. Richards
B.S.E.E. Pennsylvania State University
Special Field: Oceanographic Engineering
Dissertation: A Beam Pattern Design Procedure for Multidimensional Sonar Arrays Employing Minimum Variance Beamforming

Tom Kleindinst



Ocean Engineer

Wayne R. Blanding
B.S.E.E. United States Naval Academy
Special Field: Oceanographic Engineering
Dissertation: Observations of Ocean Fluctuations Between 15 and 23 Hour Periods in the Pacific

Robert H. Headrick
B.Sc. Oklahoma State University
Special Field: Oceanographic Engineering
Dissertation: Basin-Scale Tidal Measurements Using Acoustic Tomography

Matthew M. Sharpe
B.S.E.E. United States Naval Academy
Special Field: Oceanographic Engineering
Dissertation: The Distribution of Wave Heights and Periods for Seas with Unimodal and Bimodal Power Density Spectra

List continues overleaf



Master of Science

John A. Furgerson
B.S. University of Southern California
Special Field: Oceanographic Engineering
Dissertation: Inter-Annual Variability of Acoustic Ray Travel Times in the Northeast Pacific

Robert H. Headrick
B.Sc. Oklahoma State University
Special Field: Oceanographic Engineering
Dissertation: Basin-Scale Tidal Measurements Using Acoustic Tomography

Bruce E. Miller
B.S. United States Naval Academy
Special Field: Oceanographic Engineering
Dissertation: Observation and Inversion of Seismo-Acoustic Waves in a Complex Arctic Ice Environment

Neil R. Nickolaisen
B.S. Utah State University
Special Field: Oceanographic Engineering
Dissertation: Underwater Optical Measurement of Position and Orientation Using a Prepared, Passive Target

David M. Schubert
B.Sc. United States Naval Academy
Special Field: Physical Oceanography
Dissertation: Shipboard and Satellite Observations of Upper Ocean Velocity and Transport Variability in the Gulf Stream

Anthony J. Withnell
B.Sc. Indiana University
Special Field: Marine Geology and Geophysics
Dissertation: Relative Sea-Level Variations Revealed by Tide-Gauge Records of Long Duration

Fellows, Students, & Visitors

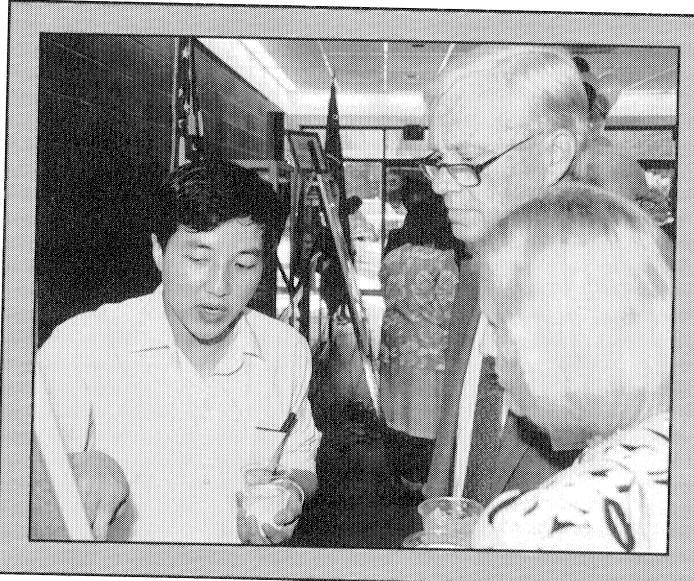
MIT/WHOI Joint Graduate Program 1989-1990 Fall Term

Einat Aharonov
Tel-Aviv University, Israel
Keith D. Alverson
Princeton University
Jamie M. Anderson
University of California, San Diego
Andrea L. Arenovsky
University of North Carolina, Wilmington
Carol Arnosti
Lawrence University
Molly O. Baringer
Tulane University
Karen G. Bemis
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Massachusetts Institute of Technology
Massachusetts Institute of Technology
Christopher R. Bradley
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Esther C. Brady
University of Massachusetts, Amherst

Edward J. Brook
Duke University
University of Montana
John R. Buck
Massachusetts Institute of Technology
Antonietta Capotondi
Liceo Scientifico, Italy
University Pisa, Italy
Changsheng Chen
Shandong College of Oceanography, PRC
Shandong College of Oceanography, PRC
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Victoria University, Australia
Edward P. Dever
Texas A&M University
Texas A&M University
Daniel T. Diperna
Lafayette College
Scott C. Doney
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Michele D. DuRand
Carleton College
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Indian Institute of Technology, India
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Flinders University, Australia
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University of Florida
Jill K. Hahn
Harvard-Radcliffe College
Boston University
Constance A. Hart
College of St. Catherine
Erik H. Hauri
University of Miami
Franz S. Hover
Ohio Northern University

Tom Kleindinst



Zheng Yu Liu was one of several students who prepared posters for presentation during annual meeting festivities. Here he discusses his work with guests at a reception in the Clark lobby.



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Texas A&M University
Massachusetts Institute
of Technology
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University of Science &
Technology, PRC
Garrett T. Ito
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Amherst
Gregory C. Johnson
Bates College
Stacy L. Kim
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Los Angeles
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Mary Washington University
Barry A. Klinger
Massachusetts Institute
of Technology
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Korea
Seoul National University,
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University Alberta, Canada
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Moscow Physical-Technical
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Young-Gyu Park
Seoul National University,
Korea
Seoul National University,
Korea
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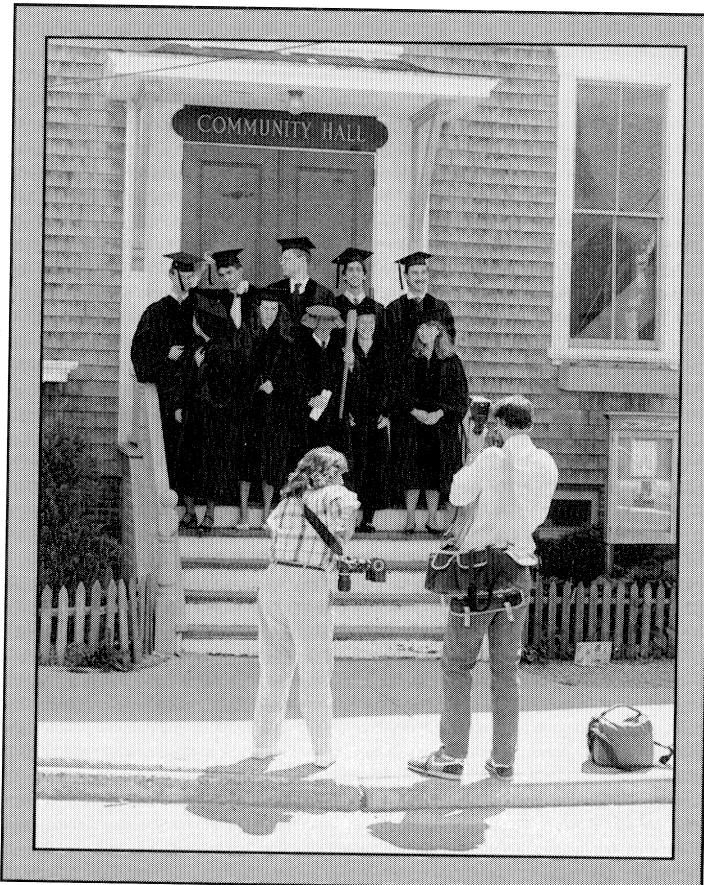
Paul E. Robbins
Oberlin College
Mindy L. Roberts
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Hebrew University, Israel
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University of California, Davis
University of California, Davis
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Memorial University, Canada

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Dajun Tang
University of Science and
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Institute of Acoustics, PRC

Photo Lab Supervisor David
Gray photographed
Photographers Terri Corbett and
Tom Kleindinst photographing
the 1990 graduates who
participated in the June
commencement ceremonies.



David Gray



LuAnne Thompson
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 Harvard University*

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*Massachusetts Institute
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 Massachusetts Institute
 of Technology*

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Kalamazoo College

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 University of Pierre and
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 New York, Oneonta*

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Brown University

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*Hamilton College
 Rice University*

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Brown University

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 Charlottesville*

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 Academia Sinica, PRC*

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*Chinese Culture
 University, ROC
 National Taiwan
 University, ROC*

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 University of California, Irvine*

Huai Min Zhang
*Peking University, PRC
 Academia Sinica, PRC*

Xiaoming Zhang
*Zhejiang University, PRC
 University of Michigan*

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Northwestern University

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University of Washington

Michael D. Degrandpre
University of Washington

Tetsu Hara
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 of Technology*

Deborah S. Kelley
Dalhousie University, Canada

Richard D. Norris
Harvard University

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*Scripps Institution
 of Oceanography*

Greg E. Ravizza
Yale University

Jeffrey S. Seewald
University of Minnesota

Tracy A. Villareal
University of Rhode Island

Robert A. Wheatcroft
University of Washington

Marine Policy and Ocean Management 1990-1991

Research Fellows

Wojciech Adamczak
N. Copernicus University

Alan S. Polasky
University of Michigan

Hongye Zhao
*Chinese Academy of
 Social Science, PRC*

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University of Washington

Athelstan F. Spilhaus
PAN/GEO Inc.

Thomas H. Tietenberg
Colby College

Predoctoral Fellows

Hauke L. Kite-Powell
*Massachusetts Institute
 of Technology*

Paul Snelgrove and Noellette
Conway examine shellfish
 collected for studies on the
 effects of disease and
 contaminants on physiological
 processes.

Summer Student Fellows

Keith G. Bauerle
University of Virginia

Benjamin A. Brooks
*University of California,
 Santa Cruz*

Gregory Ciresi
Drew University

Sabrina Drill
Virginia Polytechnic Institute

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*Massachusetts Institute
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Trinity College, Ireland

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Carleton College

Karen C. Fox
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St. Bonaventure University

Charles R. Heap
Vassar College

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*Wesleyan University
 Yale University*

Kathryn N. Smith-Knudsen
*California Polytechnic State
 University*

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Princeton University

Sandipa Malik
*George Mason University
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Harvard University

Samantha H. Messier
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University of Pittsburgh

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Juliette N. Varga
Colby College

Kathleen A. Ward
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Timothy B. Watkins
Vassar College
Diana L. Weedman
Pennsylvania State University
John C. Withey
Pomona College
Kimberley J. Woodbury
Marlboro College
Wenxiang Zhao
University of Science & Technology, PRC
Utah State University

Minority Trainees

William Castano
Georgia State University
Badrinath Rengarajan
Harvard College

Geophysical Fluid Dynamics Summer Seminar

Fellows

Neil J. Balmforth
University of Cambridge, United Kingdom
George I. Bell
Woods Hole Oceanographic Institution
Colm-Cille P. Caulfield
University of Cambridge, United Kingdom
Brian Chaboyer
Yale University
Richard R. Kerswell
Massachusetts Institute of Technology
Stefan J. Linz
Universitat des Saarlaudes, Germany
Nathan Platt
Brown University
Wendy T. Welch
University of Washington
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Columbia University

Staff Members and Lecturers

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Stevens Institute of Technology
Jonathan Arons
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Antoine Badan-Dangon
Centro de Investigacion Cientifica y de Education Superior, France

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University of Cambridge, United Kingdom
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Technion, Israel
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National Center for Atmospheric Research
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New York University
Robert Rosner
University of Chicago
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Scripps Institution of Oceanography
Robert F. Stein
Michigan State University
Engelbert Schucking
New York University
Andrew Soward
The University, United Kingdom
Edward A. Spiegel
Columbia University
Melvin E. Stern
Florida State University
Olivier Thual
National Center for Atmospheric Research
George Veronis
Yale University

John Weiss
Aware Inc.
Nigel O. Weiss
University of Cambridge, United Kingdom
Andrew W. Woods
Scripps Institution of Oceanography
Jean-Paul Zahn
Observatoire de Toulouse, France

Visiting Scholars

Nan Bray
Scripps Institution of Oceanography
Kirk Bryan
Princeton University
Paul K. Dayton
Scripps Institution of Oceanography
Steve R. Emerson
University of Washington
Darrell R. Jackson
Applied Physics Laboratory, University of Washington
Charles B. Officer
Dartmouth College

Guest Students

Merryl Alber
Boston University Marine Program
Linda A. Amaral
Brown University
Lonnie Begay
Page High School
Stephanie M. Black
Southern Utah State College
Pascal Blanc
Institut National des Telecommunications, France
Christophe Bourge
Institut National des Telecommunications, France



Tom Kleindinst

Lynn Margulis
University of Massachusetts, Amherst
Eric S. Saltzman
RSMAS, University of Miami

New Joint Program Students return in June 1990 from the program's first oceanographic orientation cruise aboard the Sea Education Association brigantine *Westward*.



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Tom Kleindinst

Scientific & Technical Staff

As of December 31, 1990

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Engineer I

Calvert F. Eck
Research Engineer

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Engineer I

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Research Associate

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Research Engineer

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Charlotte M. Fuller
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Wayne R. Geyer
Assistant Scientist

Denzel E. Gleason
Research Associate

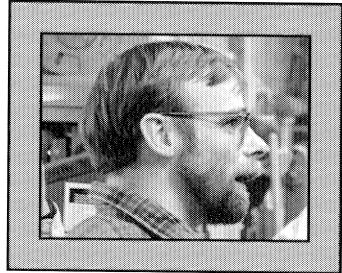
Robert G. Goldsborough
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Roger A. Goldsmith
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Manager, Information Processing
and Communications Laboratory*

Mark A. Grosenbaugh
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John T. Hallinan
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Steve Liberatore

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Research Engineer

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Research Engineer

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Engineer I

David A. Mindell
Engineer I

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Manager, Submersible Operations*
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Principal Engineer
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Research Engineer
Ehud Weinstein
Adjunct Scientist
Carl J. Wiedemann
Research Associate
Valentine P. Wilson
Research Associate
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Mary Sears
Scientist Emeritus
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Stanley W. Watson Chair
for Excellence in Oceanography*

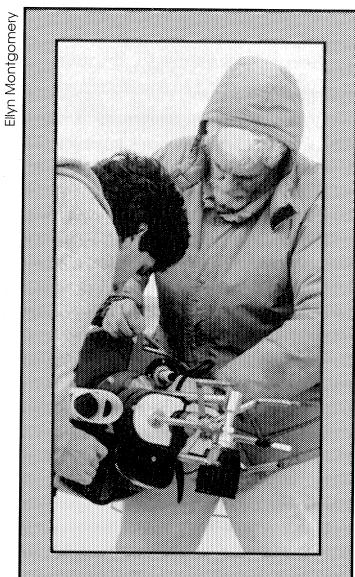


Tom Kleindinst

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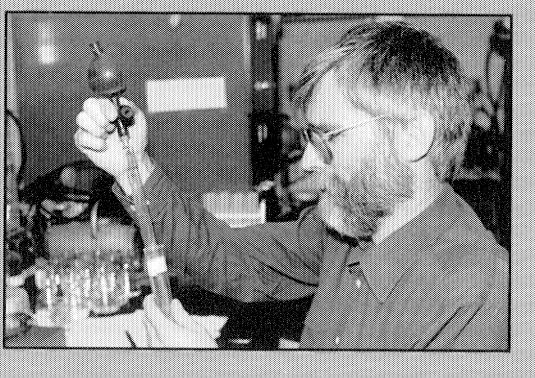
Dave Wellwood, Dick Koehler

Ellyn Montgomery



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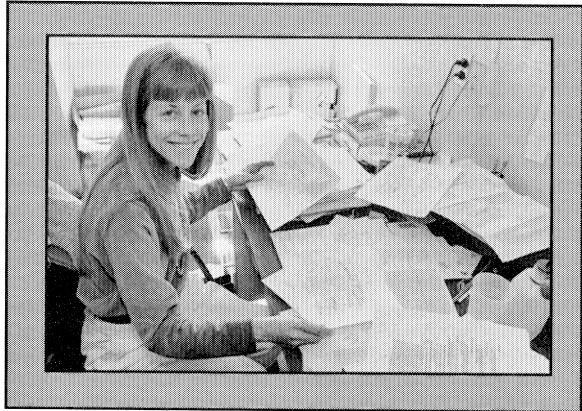
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Research Specialist

Tom Kleindinst



Melinda Hall

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F. Beecher Wooding
Research Associate
Earl M. Young
Research Associate

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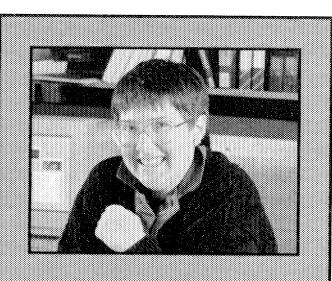
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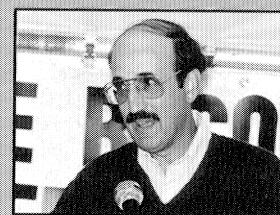
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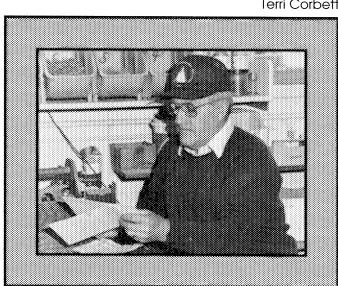
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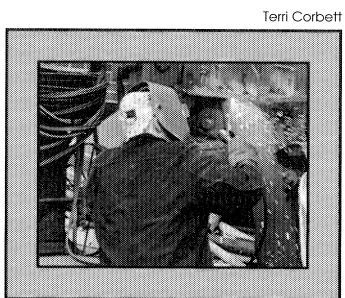
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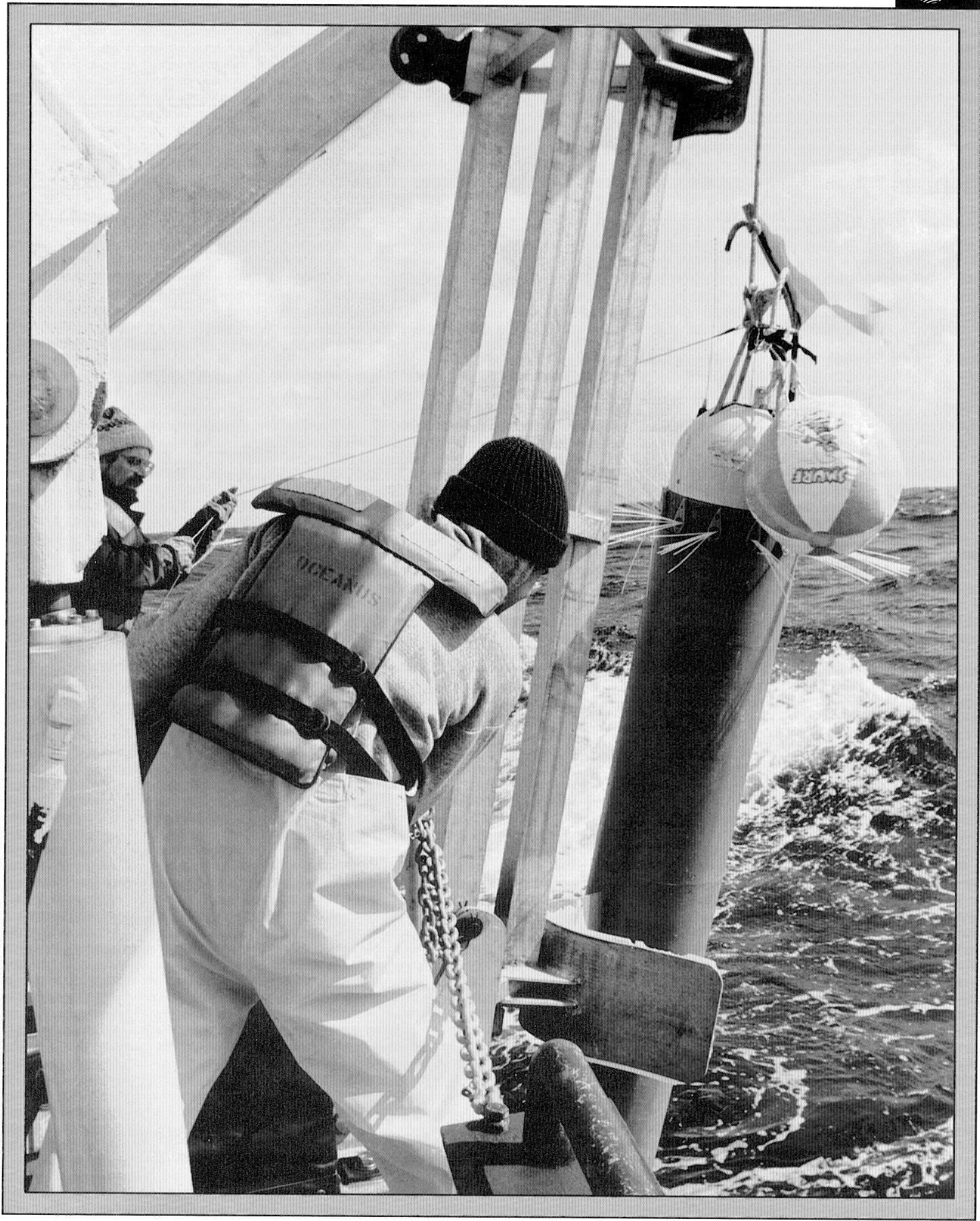
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Ray Schmitt, left, and Maggie Cook launch the High Resolution Profiler from R/V Oceanus.



Voyage Statistics

R/V Knorr

The ship was out of service during 1990 as the midlife refit continued. The work includes lengthening the ship and a variety of other improvements.

Atlantis II & DSV Alvin

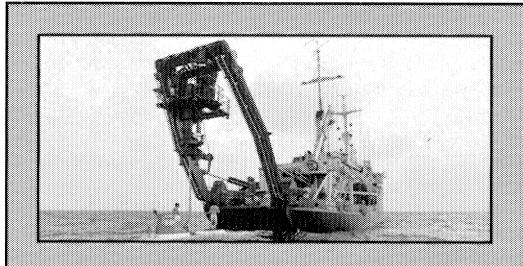
Total Nautical Miles for 1990– 20,877

Total Alvin Dives—154

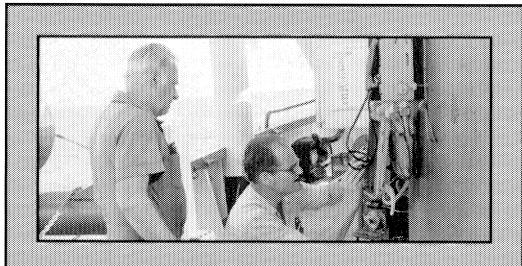
Total Days at Sea—245

Voyage	Cruise Period	Principal Objective, Area of Operations	Ports of call	Chief Scientist
125-I	29 Dec – 31 Jan '89 '90	Mid-Atlantic Ridge, investigation of hydrothermal processes, 20 dives; to shipyard for maintenance	Jacksonville, Fl	G. Thompson P. Rona (NOAA)
125-II	14 Mar – 18 Mar	Transit to Tampa	Jacksonville, FL Tampa, FL	J. Coburn
125-III	21 Mar – 22 Mar	NSF Inspection	Tampa, FL	J. Coburn
125-IV	25 Mar – 14 Apr	Gulf of Mexico, biological and chemical studies of cold water seeps, 17 dives	Galveston, TX	R. Lutz (Rutgers) J. Brooks (TAMU)
125-V	19 Apr – 29 Apr	Transit to Pacific	Puntarenas, Costa Rica	
125-VI	1 May – 22 May	Equatorial Pacific, geological studies on East Pacific Rise, 12 dives	Guayaquil, Ecuador	P. Lonsdale (SIO)
125-VII A	26 May – 15 Jun	Eastern North Pacific, biological studies at hydrothermal vents, 7 dives	Guaymas, Mexico	R. Lutz (Rutgers)
125-VII B	15 Jun – 18 Jun	Sea of Cortez, continuation of 125-VII-A, 3 dives	Guaymas, Mexico	R. Lutz (Rutgers)
125-VIII	23 Jun – 5 Jul	Sea of Cortez, coring	Guaymas, Mexico	L. Keigwin
125-IX	6 Jul – 15 Jul	Transit to Astoria, Oregon	Astoria, OR	Transit
125-X	21 Jul – 11 Aug	Juan de Fuca Ridge, study of oceanic crust evolution, vent sampling, 20 dives	Seattle, WA	P. Johnson (UW) J. Franklin (Can.G.S.)
125-XI	15 Aug – 6 Sep	Juan de Fuca Ridge, chemical studies at hydrothermal vent sites, 20 dives	Astoria, OR	R. Embley (NOAA)
125-XII	14 Sep – 28 Sep	Juan de Fuca Ridge, geological studies, 12 dives	Monterey, CA	J. Moore (UC, Santa Cruz)
125-XIII	28 Sep – 3 Oct.	Monterey Canyon, biological sampling at cold water seep sites, 3 dives	San Diego, CA	R. Lutz (Rutgers)
125-XIV	7 Oct – 27 Oct	Fieberling Guyot, biological studies at abrupt topographic features, 16 dives	San Diego, CA	L. Levin (NCSU)
125-XV	31 Oct – 9 Nov	California Coast, biological and chemical studies of sediment, 8 dives	San Diego, CA	W. Berelson (USC)
125-XVI	26 Nov – 27 Nov	California Coast, U.S. Navy Inspection , 2 dives	San Diego, CA	B. Walden
125-XVII	28 Nov – 29 Nov	California Coast, <i>Alvin</i> pilot training, 3 dives	San Diego, CA	B. Walden
125-XVIII	2 Dec – 19 Dec	Fieberling Guyot, biological studies at abrupt topographic features, 13 dives	San Diego, CA	L. Levin (NCSU)

Craig Dickson



Paul Andrew



Left Photo: DSV *Alvin* and mother ship *Atlantis II*.

Right Photo: Johnny Bizzozero and Gunter Bauerlein are at work aboard *Atlantis II*.



Kevin Kay works at the *Oceanus* engine room workbench.

Tom Kleindinst



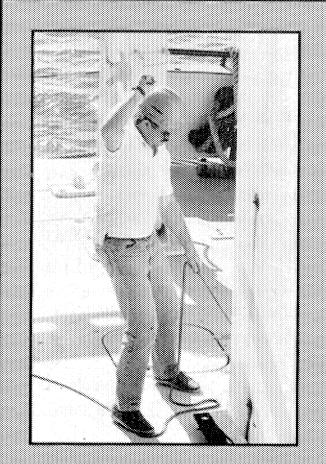
R/V Oceanus

Total Nautical Miles for 1990–14,897

Total Days at Sea—155

Voyage	Cruise Period	Principal Objective, Area of Operations	Ports of Call	Chief Scientist
217	15 Mar – 16 Mar	Engineering tests of NSF/WOCE water sampler	Woods Hole	H. Berteaux
218	20 Mar – 9 Apr	Float Studies in warm core ring	Woods Hole	R. Schmitt
219-I	16 Apr – 22 Apr	Engineering tests of NSF/WOCE water sampler	Bermuda	H. Berteaux
219-II	22 Apr – 23 Apr	Deploy subsurface mooring/RAFOS sound projector	Bermuda	T. Rossby (URI)
219-III	26 Apr – 27 Apr	Redeploy the Engineering Surface Oceanographic Mooring	Bermuda	P. Clay
219-IV	28 Apr – 3 May	Engineering tests of NSF/WOCE water sampler	Woods Hole	W. Jenkins
220	22 May – 13 Jun	Investigation of upper ocean physics on small surface waves	Woods Hole	D. Carlson (OSU)
221	12 Jul – 26 Jul	Examine the grazing dynamics of micro-flagellates upon marine unicellular cyanobacteria	Woods Hole	J. Waterbury
222	2 Aug – 7 Aug	Collect bottom samples at Deep-Water Dumpsite-106	Woods Hole	J. F. Grassle (Rutgers)
223	8 Sep-10 Sep	Test High Resolution Profiler weight release system and new sensors	Woods Hole	J. Toole
224	17 Sep – 27 Sep	Surface Wave Dynamics Experiment (SWADE): deployment of surface mooring array	Woods Hole	H. Gruber
225	2 Oct – 25 Oct	Studies of the microbial ecology of oceanic plankton and benthic communities	Bermuda	D. Caron
226	28 Oct – 31 Oct.	SWADE: deploy Wavescan mooring	Woods Hole	H. Gruber
227-I	4 Nov – 27 Nov	Biochemical studies of decomposition rates of organic matter, calcium carbonate and biogenic silica, influence of organic matter on sludge deposited at Deep-Water Dumpsite-106	Bermuda-Woods Hole	W. Martin/J.F. Grassle
227-II	14 Nov – 23 Nov		Woods Hole-Bermuda	W. Martin/J.F. Grassle
227-III	24 Nov – 26 Nov		Bermuda-Woods Hole	W. Martin/J.F. Grassle
228	30 Nov – 3 Dec	Environmentally Controlled Ocean Floor Noise Monitoring Experiment: Recover ocean bottom hydrophones	Woods Hole	M. Purdy
229	6 Dec – 10 Dec	Tracer injector instrumentation test	Woods Hole	J. Ledwell

Tom Kleindinst



Ellen Prihodko



Left Photo: Doug Mayer handles a line aboard *Oceanus*.

Right Photo: Surface Wave Dynamics Experiment gear is loaded on *Oceanus*.



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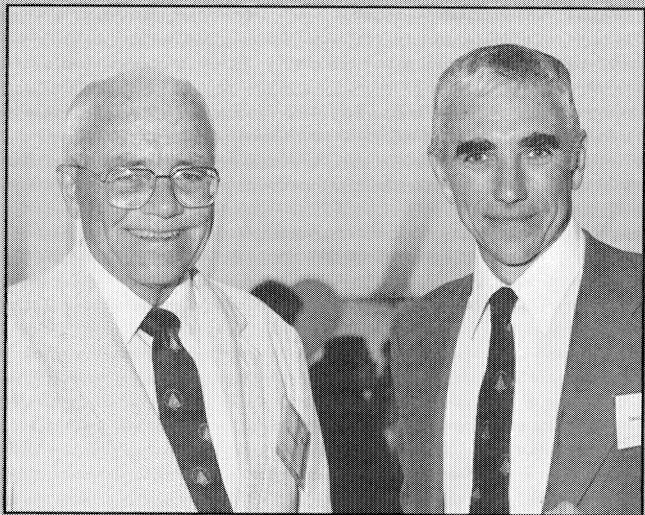
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Guy Nichols and Craig Dorman under the tent at the June dinner.



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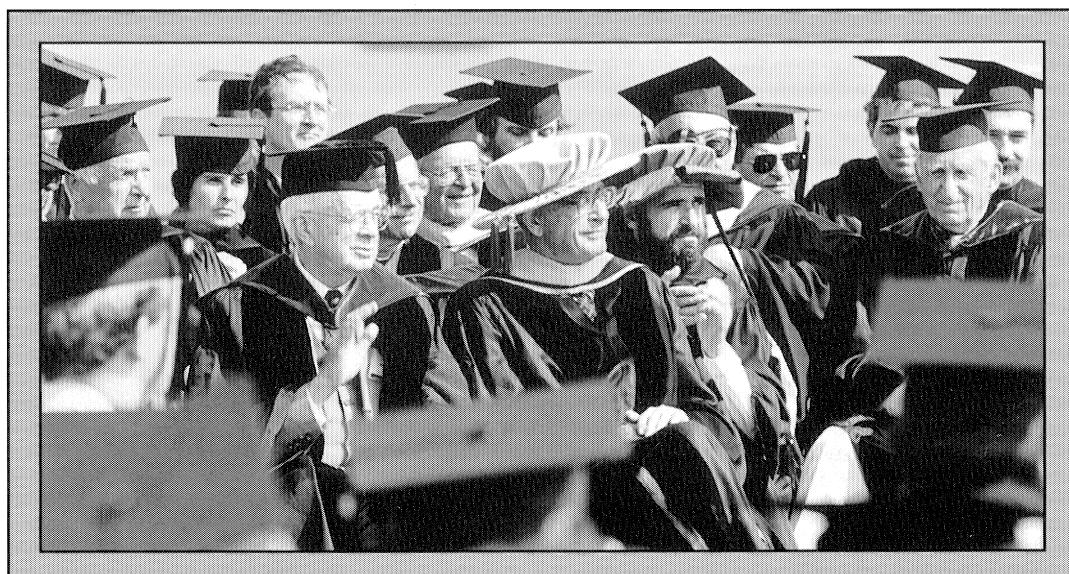
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In Memoriam

The Institution gratefully acknowledges the service and support of:

Alan C. Bemis
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Harold E. Edgerton,
Gerard A. Fulham,
Richard W. Pratt,
James H. Wakelin, Jr.,
Albert A. T. Wickersham.



The pier was a sea of mortar boards at June commencement ceremonies.



Financial Statements

THE Institution's financial results depict a steady year. In 1990, total revenues decreased by 5.6% to \$77,711,259 from \$82,293,250, a change of \$4,581,991. This decrease was the result of the *Knorr/Melville* refit expenditures being lower than the previous year by \$4,667,907.

Excluding the *Knorr/Melville* refit, government sponsored research increased by \$2,692,493 while nongovernment research decreased by \$2,170,670, a net increase of \$521,823 over the previous year. For government research, the National Science Foundation showed a \$769,227 decrease, down 2.8% due to reduced ship operation support as a result of the *Knorr* refit. Research funding from the United States Navy increased by \$2,580,912, up 14.4%, due primarily to new programs in tactical oceanography. Other government funding advanced by \$880,808, an increase of 20.2%. The decrease of \$2,170,670 from nongovernment sources was principally associated with the Jason Program. In 1989 the Institution was the prime contractor for the Jason program, while in 1990 this responsibility was assumed by the Jason Foundation for Education. The backlog at year end of sponsored research excluding the vessel refit

increased \$4,340,209 to \$32,094,815. Other income decreased \$675,498 principally because 1990 capital expenditures reduced the fund balances earning interest income.

Total expenses decreased \$2,539,969 to \$77,242,376 from \$79,782,345, a decrease of 3.2% from 1989. Costs of sponsored research, excluding the *Knorr/Melville* refit, increased by \$521,823, up 0.9%. Education expenses increased 10.5% due to increasing faculty costs while other expenses increased 41.0%, principally unsponsored research costs in support of unfunded scientific staff.

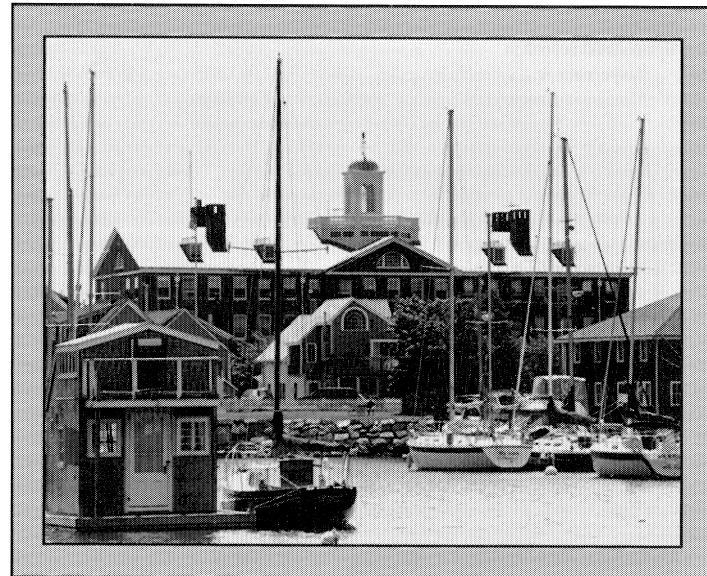
At year end, current net unrestricted funds of \$100,000 were transferred to unexpended plant funds, and \$500,000 to replenish the Director's Innovative Fund.

In 1990, gifts and grants from private sources decreased by \$792,429 to \$3,022,347 from \$3,814,776, due primarily to the Development Office's focus on the planning and implementation of a major capital campaign.

The market value of the endowment including new gifts of \$233,859 decreased by \$4,004,652 to \$97,645,461 from \$101,650,113, reflecting the general market decline during the year.

Capital expenditures totalled \$8,259,173 in 1990, an increase of \$2,073,933 over 1989. Total expendi-

tures included \$3,251,446 for the Clark addition and \$1,953,152 for the National Ocean Sciences Accelerator Mass Spectrometry



Terr Corbett

Facility. Funds for capital expenditures were provided from depreciation recovery, unrestricted income, and grants from government agencies.

The number of employees at year end increased by 17 to 884.

You are invited to review the Institution's audited financial statements and accompanying notes presented on the following pages.

*Gary B. Walker
Assistant Director
for Finance
& Administration*

*Kenneth S. Safe, Jr.
Treasurer*

*George A. Smith
Controller*

The Bigelow Laboratory cupola is framed by masts of sailboats moored in Eel Pond.



Statements of Current Fund Revenues, Expenses and Transfers for the years ended December 31, 1990 and 1989

	1990	1989
Revenues:		
Sponsored research:		
Government	\$52,392,315	\$49,699,822
Nongovernment	7,125,979	9,296,649
	<u>59,518,294</u>	<u>58,996,471</u>
<i>Knorr/Melville</i> refit	9,960,627	14,628,534
Education funds availed of	2,681,378	2,441,787
Total restricted	<u>72,160,299</u>	<u>76,066,792</u>
Unrestricted:		
Fees	392,672	488,004
Endowment income	1,423,222	1,498,394
Gifts	995,015	1,177,655
Tuition	1,307,704	1,150,474
Investment income	530,104	1,273,869
Oceanus subscriptions	347,834	289,104
Other	<u>554,409</u>	<u>348,958</u>
Total unrestricted	<u>5,550,960</u>	<u>6,226,458</u>
	<u>77,711,259</u>	<u>82,293,250</u>
Expenses:		
Sponsored research:		
Salaries and fringe benefits	17,820,188	17,178,058
Ships and submersibles	6,746,322	6,943,470
Material and equipment	8,670,267	10,127,523
Subcontracts	3,939,599	4,609,922
Laboratory overhead	6,729,737	5,472,190
General and administrative	6,103,788	5,346,493
Other	<u>9,508,393</u>	<u>9,318,815</u>
	<u>59,518,294</u>	<u>58,996,471</u>
<i>Knorr/Melville</i> refit	9,960,627	14,628,534
Education:		
Faculty expense	1,469,065	1,359,440
Student expense	1,087,691	985,430
Postdoctoral programs	435,616	405,609
Other	<u>342,858</u>	<u>266,545</u>
	<u>3,335,230</u>	<u>3,017,024</u>
Unsponsored research	2,274,444	1,256,896
External affairs	1,641,675	1,519,841
Other activities	512,106	363,579
Total expenses	<u>77,242,376</u>	<u>79,782,345</u>
Net increase before transfers	<u>468,883</u>	<u>2,510,905</u>
Transfers - (to) from:		
Designated reserves	(344,580)	(1,012,496)
Plant fund	<u>(100,000)</u>	<u>(1,900,000)</u>
Other	-	(10,899)
Total	<u>(444,580)</u>	<u>(2,923,395)</u>
Net increase (decrease) - unrestricted current funds	<u>\$24,303</u>	<u>\$(412,490)</u>

Balance Sheets December 31, 1990 and 1989

	1990	1989
ASSETS		
Current fund (Note A) :		
Cash	\$14,991,921	\$9,652,026
Short-term investments, at cost which approximates market	4,441,454	15,356,620
Accrued interest and dividends	856,489	982,221
Reimbursable costs and fees:		
Billed	2,708,514	1,388,283
Unbilled	1,161,620	941,050
Other receivables	502,310	472,708
Inventories	519,676	425,090
Deferred charges and prepaid expenses	423,800	691,380
Deferred fixed rate variances	2,234,452	1,823,828
Due to other funds	<u>(2,703,219)</u>	<u>(7,148,192)</u>
	<u>25,137,017</u>	<u>24,585,014</u>
Endowment fund (Notes A and B) :		
Investments, at market	84,062,578	88,954,391
Cash and cash equivalents	12,951,220	12,309,750
Pooled income investments, at market	193,663	194,629
Due from current fund	263,400	29,316
	<u>97,470,861</u>	<u>101,488,086</u>
Annuity investments, at market	174,600	162,027
	<u>97,645,461</u>	<u>101,650,113</u>
Plant fund (Note A) :		
Land, buildings, and improvements	36,540,455	30,757,821
Vessels and dock facilities	7,403,251	7,395,774
Laboratory and other equipment	6,011,146	5,412,765
Work in process	399,366	218,196
	<u>50,354,218</u>	<u>43,784,556</u>
Less: accumulated depreciation	<u>(21,398,715)</u>	<u>(19,383,653)</u>
	<u>28,955,503</u>	<u>24,400,903</u>
Due from current fund	2,439,819	7,118,876
	<u>31,395,322</u>	<u>31,519,779</u>
Total all funds	<u>\$154,177,800</u>	<u>\$157,754,906</u>
LIABILITIES AND FUND BALANCES		
	1990	1989
Current Fund:		
Liabilities:		
Accounts payable and other liabilities	\$2,153,566	\$4,405,299
Accrued payroll and related liabilities	3,917,359	3,513,783
	<u>6,070,925</u>	<u>7,919,082</u>
Fund balances:		
Restricted-unexpended:		
Sponsored research	11,217,590	9,516,160
Education program	3,605,440	3,154,468
Designated	2,178,018	1,954,563
Unrestricted	2,065,044	2,040,741
	<u>19,066,092</u>	<u>16,665,932</u>
	<u>25,137,017</u>	<u>24,585,014</u>
Endowment Fund:		
Endowment:		
Income restricted	56,792,656	59,380,215
Income unrestricted	1,144,312	1,149,546
Quasi-endowment:		
Income designated	14,678,694	14,842,974
Income unrestricted	24,855,199	26,115,351
	<u>97,470,861</u>	<u>101,488,086</u>
Annuity	174,600	162,027
	<u>97,645,461</u>	<u>101,650,113</u>
Plant Fund:		
Invested in plant	28,955,503	24,400,903
Unexpended:		
Restricted	60,594	102,852
Unrestricted	2,379,225	7,016,024
	<u>31,395,322</u>	<u>31,519,779</u>
Total all funds	<u>\$154,177,800</u>	<u>\$157,754,906</u>



Statement of Changes in Fund Balances for the year ended December 31, 1990

	Current Funds				Endowment Fund	Plant Fund		Total All Funds	
	Restricted	Designated	Unrestricted	Total		Invested in Plant	Unexpended	1990	1989
Increases:									
Gifts, grants and contracts:									
Government	\$62,981,935			\$62,981,935				\$62,981,935	\$66,024,295
Nongovernment	7,218,777		\$995,015	8,213,792	\$ 233,859		\$ 42,382	8,490,033	10,539,378
Endowment and similar funds	3,783,684		1,423,222	5,206,906				5,206,906	5,491,011
Net increase (decrease) in realized and unrealized appreciation					(4,895,210)			(4,895,210)	9,724,601
Supplemental retirement plan					562,058			562,058	1,640,000
Other	294,217		3,132,723	3,426,940	2,724		767	3,430,431	3,800,243
Total increases	74,278,613		5,550,960	79,829,573	(4,096,569)		43,149	75,776,153	97,219,528
Decreases:									
Expenditures	(72,160,299)		(5,082,077)	(77,242,376)				(77,242,376)	(79,782,345)
Depreciation (Note A) ...						\$2,346,527	2,084,713	(261,814)	(261,814)
Plant asset additions						6,901,127	(6,901,127)	-	-
Other	(912)			(912)				(912)	(189,664)
Total (decrease) increase	(72,161,211)		(5,082,077)	(77,243,288)	-	4,554,600	(4,816,414)	(77,505,102)	(80,233,823)
Net change before transfers	2,117,402		468,883	2,586,285	(4,096,569)	4,554,600	(4,773,265)	(1,728,949)	16,985,705
Transfers-additions/(deductions):									
Current revenues to:									
Plant funds			(100,000)	(100,000)			100,000	-	-
Designated reserves		\$344,580	(344,580)					-	-
Other transfers	35,000	(121,125)		(86,125)	91,917		(5,792)	-	-
Total transfers	35,000	223,455	(444,580)	(186,125)	91,917		94,208	-	-
Change in fund balances for year	2,152,402	223,455	24,303	2,400,160	(4,004,652)	4,554,600	(4,679,057)	(1,728,949)	16,985,705
Fund balance, December 31, 1989	12,670,628	1,954,563	2,040,741	16,665,932	101,650,113	24,400,903	7,118,876	149,835,824	132,850,119
Fund balance, December 31, 1990	<u>\$14,823,030</u>	<u>\$2,178,018</u>	<u>\$2,065,044</u>	<u>\$19,066,092</u>	<u>\$97,645,461</u>	<u>\$28,955,503</u>	<u>\$2,439,819</u>	<u>\$148,106,875</u>	<u>\$149,835,824</u>

The accompanying notes are an integral part of the financial statements.

Report of Independent Accountants To the Board of Trustees of Woods Hole Oceanographic Institution:

We have audited the accompanying balance sheet of Woods Hole Oceanographic Institution as of December 31, 1990 and the related statements of changes in fund balances, and of current fund revenues, expenses and transfers for the year then ended. We previously audited and reported upon the financial statements of the Institution for the year ended December 31, 1989; totals for that year are shown for comparative purposes. These financial statements are the responsibility of the Institution's management. Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with generally accepted auditing standards. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial

statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

In our opinion, the financial statements referred to above present fairly, in all material respects, the financial position of Woods Hole Oceanographic Institution as of December 31, 1990, the changes in its fund balances, and its current fund revenues, expenses and transfers for the year then ended, in conformity with generally accepted accounting principles.

Boston, Massachusetts
April 5, 1991

Coopers & Lybrand



Notes to Financial Statements

A. Summary of Significant Accounting Policies:

Fund Accounting

The accompanying financial statements have been prepared on the accrual basis. In order to comply with the internal designations and external restrictions placed on the use of the resources available to the Institution, the accounts are maintained in accordance with the principles of fund accounting. This procedure classifies resources into various funds in accordance with their specified activities or objectives.

Cash

Included in cash at December 31, 1990 and 1989 is \$14,750,553 and \$9,807,506, respectively, representing advances received from the United States Navy. Such amounts are restricted in use to certain vessel refit and other research programs. Interest earned on unspent funds reverts to the federal government.

Investments

Investment securities held by the Endowment Fund are carried at market value determined as follows: securities traded on a national securities exchange are valued at the last reported sales price on the last business day of the year; securities traded in the over-the-counter market and listed securities for which no sales prices were reported on that day are valued at closing bid prices. Purchases and sales of investment securities are recorded on a trade date basis. Realized gains and losses are computed on a specific identification method.

Investment income, net of investment expenses, is distributed on the unit method. Unrestricted investment income is recognized as revenue when earned and re-

stricted investment income is recognized as revenue when it is expended for its stated purpose. Realized and unrealized gains and losses are recognized on a specific fund basis.

Contracts and Grants

Revenues earned on contracts and grants are recognized as related costs are incurred. The Institution has negotiated with the federal government fixed rates for the recovery of certain indirect costs. Such recoveries are subject to carryforward provisions that provide for adjustments to be included in the negotiation of future fixed rates. The deferred fixed rate variance account represents the cumulative amount owed to or from the federal government.

Gifts

Unrestricted gifts are recognized as revenue when received and restricted gifts are recognized as revenue as they are expended for their stated purposes.

Noncash gifts are generally recorded at market value on the date of gift, although certain noncash gifts for which a readily determinable market value cannot be established are recorded at a nominal value until such time as the value becomes known.

Plant

Plant assets are stated at cost. Depreciation is provided on a straight-line basis at annual rates of 2% to 12 1/2% on buildings and improvements, 3 1/2% on vessels and dock facilities and 20% to 33 1/3% on equipment. Depreciation expense on plant assets purchased by the Institution amounting to \$2,084,713 in 1990 and \$1,607,080 in 1989, has been charged to operating expenses. Depreciation on certain government funded facilities (*Atlantis II*, the Laboratory for Marine Science and the dock facility, amounting to \$261,814 in each year) is accounted for as a direct reduction of the plant asset and invested in plant fund. Title to the research vessel *Atlantis II* is contingent upon its continued use for oceanographic research.

The Institution consolidates available cash from the plant fund with other cash in the current fund for investment purposes.

B. Endowment Fund Investments:

The cost and market value of investments held at December 31, 1990 and 1989 are as follows:

	1990		1989	
	Cost	Market	Cost	Market
Government and government agencies	\$18,002,572	\$18,317,663	\$22,229,145	\$22,269,101
Convertible bonds	1,209,755	936,325	256,808	256,500
Corporate bonds	8,988,293	9,075,881	10,116,249	10,570,631
Other bonds	824,143	829,007	333,982	345,092
Common stock	51,538,959	52,460,264	47,457,881	53,876,864
Other	2,478,019	2,443,438	1,685,719	1,636,203
Total investments	\$83,041,741	\$84,062,578	\$82,079,784	\$88,954,391

C. Investment Units:

The value of an investment unit at December 31, 1990 and 1989 was \$1.8532 and \$1.9471, respectively. The investment income per unit for 1990 and 1989 was \$.1016 and \$.1073, respectively.

	1990	1989
Unit value, beginning of year	\$1.9471	\$1.7596
Unit value, end of year	1.8532	1.9471
Net change for the year	(.0939)	.1875
Investment income per unit for the year1016	.1073
Total return per unit	\$.0077	\$.2948

D. Endowment Income:

Endowment income consisted of the following:

	1990	1989
Interest and dividends	\$5,668,281	\$5,920,374
Investment management costs	(461,375)	(429,363)
Net endowment income	\$5,206,906	\$5,491,011

E. Retirement Plans:

The Institution maintains two noncontributory defined benefit pension plans covering substantially all employees of the Institution. Pension benefits are earned based on years of service and compensation received. The Institution's policy is to fund pension cost accrued.

Combined net pension expense for two plans consisted of the following for 1990:	
Service cost	\$ 2,927,488
Interest cost	4,691,555
Actual return on plan assets	(761,931)
Net amortization and deferral	(5,059,809)
Net pension expense	\$ 1,797,303

Below is a reconciliation of the combined funded status of the plans at December 31, 1990:

Accumulated benefit obligation:	
Vested benefits	\$44,047,767
Nonvested benefits	4,899,743
Total accumulated benefit obligation	48,947,510
Projected benefit obligation	68,596,749
Market value of plan assets	69,260,967
Plan assets in excess of the projected benefit obligation	(664,218)
Unrecognized net transition asset	5,695,360
Unrecognized prior service costs	(656,149)
Unrecognized net loss	(2,172,935)
Accrued pension cost	\$ 2,202,058

In addition to the \$69,260,967 of plan assets listed above, the Institution has approximately \$2,202,058 available at December 31, 1990 to fund certain benefits.

The discount rate and rate of increase in future compensation used to determine the projected benefit obligation as of December 31, 1990 were 7.25% and 7.06%, respectively. The expected return on plan assets was 8.25%.

F. Postretirement Health Care Benefits:

In addition to providing pension benefits, the Institution provides certain health care benefits for retired employees and their spouses. Substantially all of the Institution's employees may become eligible for the benefits if they reach normal retirement age (as defined) or elect early retirement with certain time in service limitations. The cost of retiree health care is recognized as an expense when paid. These costs amounted to \$344,700 in 1990 and \$240,912 in 1989.

G. Contingency:

The Institution contracted with a shipyard in 1989 to perform certain refit and modifications to the R/V *Knorr* and *Metville*. The project was funded by the United States Navy. During 1990, certain delays and contractual disputes occurred between the Institution and the shipyard. Subsequent to December 31, 1990, the matter has been presented to the American Arbitration Association for resolution as stipulated in the contract. Arbitration hearings are expected to commence during 1991. At December 31, 1990, any potential liability for additional costs required to complete the contracted work is not quantifiable. In addition, the Institution is evaluating its sources of additional available funding should this be required.



Elyn Montgomery



Ray Schmitt hooks up the data recovery cable following a dive of the High Resolution Profiler.