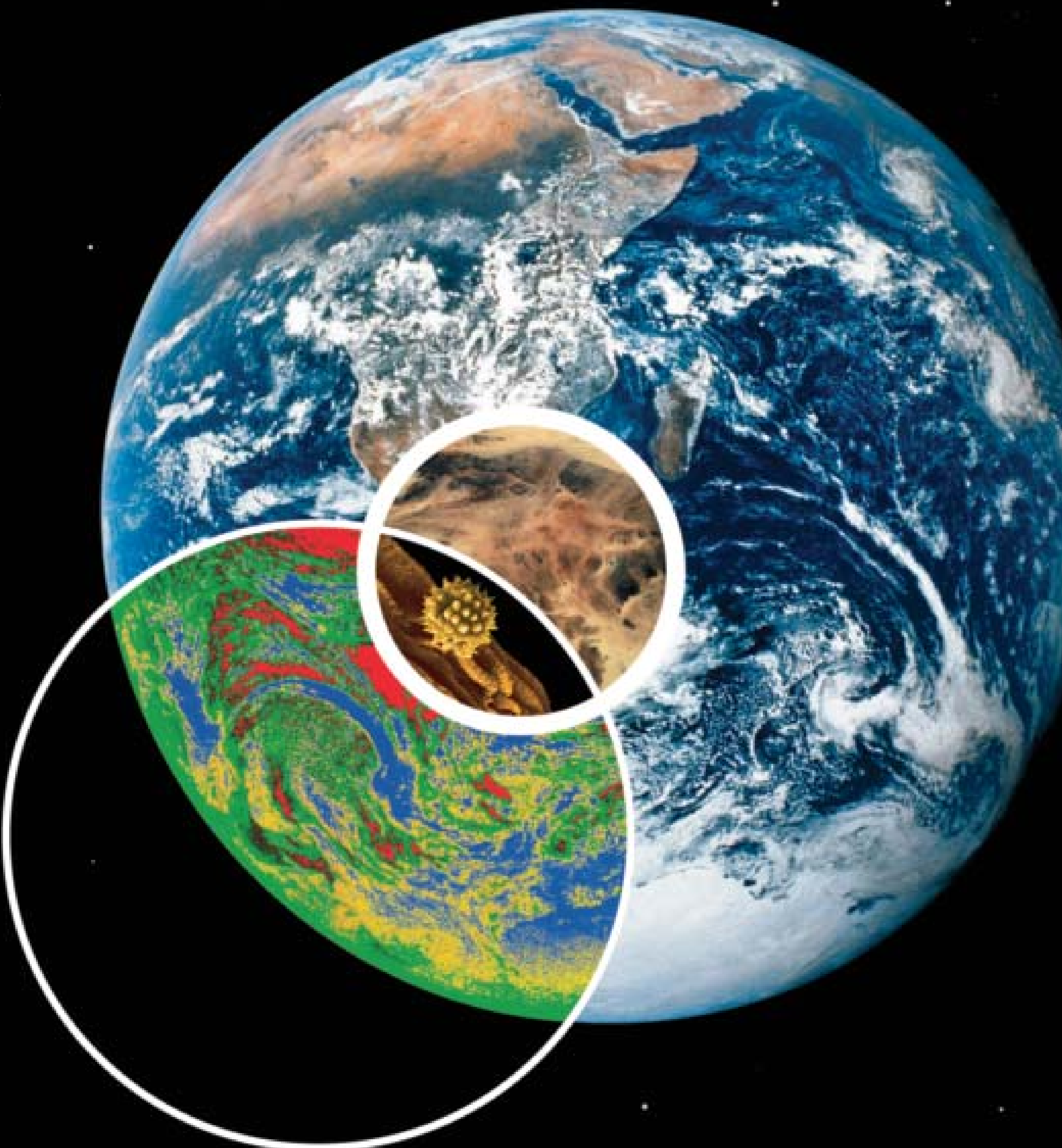
Biennial Report 2000–2002



Lamont–Doherty Earth Observatory
The Earth Institute at Columbia University

BIENNIAL REPORT 2000–2002

LAMONT-DOHERTY EARTH OBSERVATORY THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

About the Cover

Photograph of Earth from the Apollo 17 mission

Satellite image of the Libyan Desert

Colorized scanning electron micrograph. © Dee Breger
Pollen grain fertilizing goldenrod flower through a pollen tube grown after landing on the stigma

Color enhanced photograph of Earth from the Apollo 17 mission provided by DigitalVision

Below: Two crew members aboard the R/V *Ewing* look out on glacier-derived icebergs near the Palmer Archipelago, west of the Antarctic Peninsula. Credit: John Diebold

Lamont-Doherty Earth Observatory is renowned in the international scientific community for its success and innovation in advancing understanding of Earth, for its unique geological and climatological archives and state-of-the-art laboratory facilities, and for the outstanding achievement of its graduates. Observatory scientists observe Earth on a global scale, from its deepest interior to the outer reaches of its atmosphere, on every continent and in every ocean. They decipher the long record of the past, monitor the present, and seek to foresee Earth's future. From global climate change to earthquakes, volcanoes, nonrenewable resources, environmental hazards and beyond, the Observatory's fundamental challenge is to provide a rational basis for the difficult choices faced by humankind in the stewardship of this fragile planet.

G. Michael Purdy
Director, Lamont-Doherty Earth Observatory

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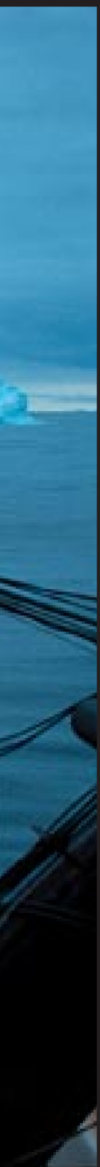


Letter from the Director

The six years since Lamont-Doherty Earth Observatory last published a biennial report in 1996 have been ones of dramatic change. This report—covering the period from July 2000 through June 2002—marks the beginning of a renewed resolve to pursue energetic growth of the Observatory as a world leader in Earth and environmental research and education.

I was privileged to take on the leadership of this great institution in December 2000. I have spent the last two years discovering the wealth of intellectual talent and the substantial diversity of research programs at the Observatory and learning how best to steer this legendary center of scientific inquiry through the complex challenges of modern day research and education in the United States.

Unquestionably the most important changes at Lamont in the past six years relate to the establishment of The Earth Institute at Columbia University. This innovative and ambitious construct, which for the first time enables effective interaction between the research disciplines of fundamental Earth and environmental sciences and those of economics, policy and engineering, will shape the future of the Observatory in many important ways.

Two significant units of The Earth Institute are located, along with the Observatory, on the Lamont campus: the International Research Institute for Climate Prediction and the Center for International Earth Science Information Network. In addition, two new Earth Institute centers—the Center for Hazards and Risk Research and the Center for Rivers and Estuaries—are being established and will play a prominent role in shaping future research agendas.

A number of extraordinary accomplishments have propelled the Observatory forward in fulfillment of its mission of furthering our basic understanding of Earth. As the narrative that follows demonstrates, the intellectual breadth of research endeavors, the diversity of research approaches, and the determination to maintain flexible, discovery-driven research integrated with education activities all serve to build a uniquely powerful and healthy institution.

I am confident that after reading this report you will be convinced that, over the past two years, the Observatory has contributed in substantial and important ways to our understanding of Earth's oceans, climate and deep structure and furthered our knowledge of its complex coastal and estuarine environments and the processes shaping a wide range of natural hazards.

I would ask that you remember that what makes this progress possible is the quality and dedication of all the staff here at Lamont. Only their intellect, hard work and continued determination will allow the Observatory to maintain its worldwide reputation as a leader in this crucially important, and increasingly urgent, business of understanding our Earth.

G. Michael Purdy
Director

Letter from the Director of The Earth Institute

Dear Friends of Lamont-Doherty:

The goal of The Earth Institute at Columbia University is the mobilization of science and public policy to address the problems of sustainable development in the 21st century.

The Lamont-Doherty Earth Observatory is the foundation of this important initiative. Established in 1949, when Columbia's leading Earth scientists moved up the Hudson to Thomas Lamont's spectacular property, the Observatory is the first of The Earth Institute's research units, the most famous, the longest standing, and to date, the largest. It has played a significant role in the formation and leadership of The Earth Institute, and will continue as a leader in the future.

The Observatory's scientists have contributed substantially to our fundamental understanding of Earth's systems, whether climate, plate tectonics or the physical environment in which human society lives. In their laboratories and in the field, they have been pioneers in addressing key problems that grow out of the interaction between human society and the physical environment. Long before others, Observatory scientists were seeking solutions to large-scale problems for human betterment.

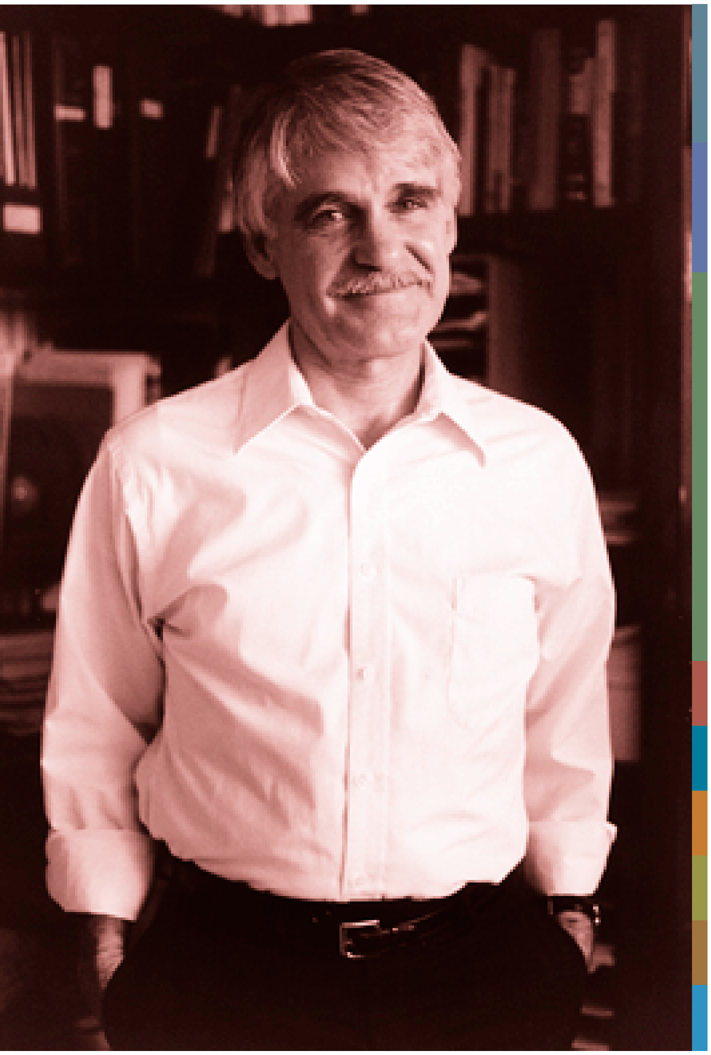
Under the leadership of Michael Purdy, the Observatory is at an exciting new juncture in its development as a leading center of scientific inquiry. In close collaboration with the major science departments on Columbia's Morningside campus and with the Earth Institute, the Observatory is recruiting new scientific talent. These star scholars will bring new leadership in areas as diverse as marine ecosystem modeling, coastal and estuarine processes, and geochemistry, building upon the Observatory's expertise and leadership in the understanding of Earth's deep interior. The intellectual breadth of its researchers, and the ability to study Earth's marine, terrestrial and atmospheric systems in powerfully integrated ways, remain the Observatory's greatest strengths. I look forward to working with Mike and his distinguished team to reach our shared goal of strengthening Columbia University's leadership role in Earth and environmental science research and education.

Education of future leaders in sustainable development is a critical challenge for The Earth Institute. So that more students can be engaged both in science at the Observatory and the intersection of science with public policy, Columbia is strengthening the links between the Lamont and Morningside campuses. From more integration of teaching programs to more frequent shuttle transportation between the two campuses, these links will enable us to take greater advantage of the wealth of educational opportunity at the Observatory—as well as at the other important units of the Institute, such as the Center for International Earth Science Information Network, the International Research Institute for Climate Prediction, the Center for Hazards and Risk Research and the new Center for Rivers and Estuaries, that make up the rest of the Lamont campus.

I have great hopes that, through the integrating work of The Earth Institute, science will play an increasingly important role in our ability to respond to the most pressing challenges of our time and improve the conditions in which the world's most vulnerable citizens live. With enhanced understanding of climate change, of the history of Earth's physical environment, and of the effects that humans have on Earth's systems, the work of our esteemed Lamont colleagues will help us to secure a sustainable future for all.

Jeffrey D. Sachs
Director, The Earth Institute at Columbia University

Biology and Paleo Environment



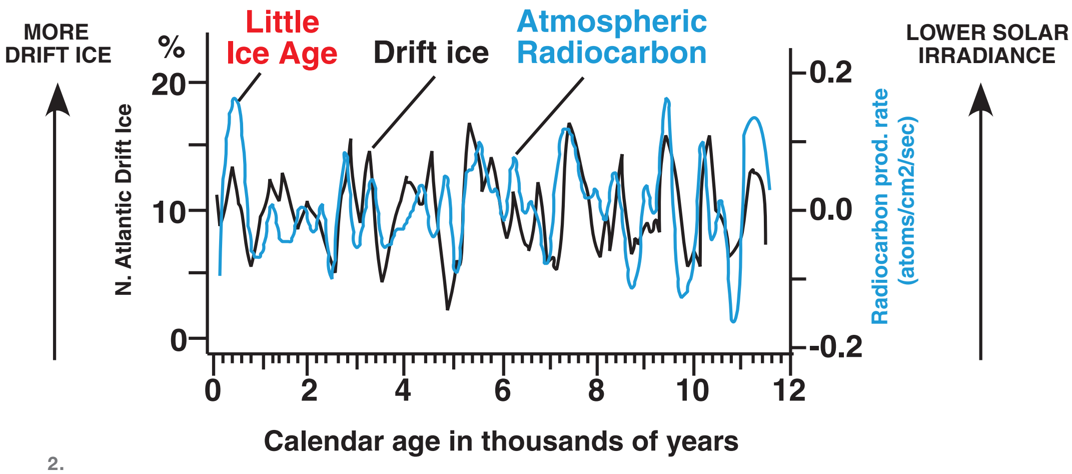
1.

John Marra, Doherty Senior Scholar
Associate Director, Biology and Paleo Environment

A seemingly disparate group of oceanographers, geochemists, biologists and environmental scientists, researchers in the Biology and Paleo Environment Division (B&PE) pursue two connected efforts: to uncover how biology helps to make sense of the paleo environment—or fossils as indicators of Earth's past—and to understand how the environment, through its oceans, atmosphere and land, affects present-day biology.

The fossil remains of organisms from the geologic past are but one of the resources researchers in B&PE use to uncover clues to Earth's environmental history. All organisms record the environment in which they exist. Factors such as temperature, availability of water, nutrients, light and chemical or physical changes that stress the system shape the organisms just as these organisms exert an influence on their surrounding environment. By studying these organisms, scientists can construct a clear picture of Earth's past, shedding new light on how the current climate system works and what can be expected in the future.

B&PE scientists turn to a number of other primary sources to conduct their research, notably the Observatory's world-class collection of deep-sea sediment columns, coral reefs and tree rings. These deep-sea sediment columns are like tape recordings and allow scientists to look at Earth's history over the last several million years. Coral-based climatic reconstructions—using both living and drowned (fossil) reefs—provide an alternate, independent means of accurately testing the data collected by other means and extending the record into pre-anthropogenic times. The width of tree rings, formed as trees grow and lay down wood seasonally, reflects the temperature and precipitation experienced during that growing season. By studying trees several hundred years old, scientists can establish an accurate record of the climate for that particular location.



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2. The black line represents the percentage of a distinct type of iron-coated sand grain that melted out of icebergs and sea ice in the eastern North Atlantic. The blue line represents the change in the production of radiocarbon in the atmosphere; production rate increases are linked to decreases in the sun's irradiance.
The remarkably close match of the two records shows that during the last 12,000 years every colder period in the North Atlantic is linked to a weaker sun. This strongly suggests that cold events such as the recent Little Ice Age, when glaciers advanced in both hemispheres, are not random phenomena but are part of a cyclic sun-related process that will likely continue into the future. Credit: Gerard Bond

3. For his advanced course, Plant Physiological Ecology taught by Kevin Griffin, graduate student Rob Carson took a 180-degree fish eye (hemispherical) photo of Black Rock Forest. This photo illustrates the openness of the canopy above, which in large part determines how much light ultimately reaches the forest floor. Credit: Rob Carson

4. Gordon Jacoby cores a Siberian pine in Mongolia to obtain paleoclimatic information from its annual rings. By analyzing tree rings, scientists can learn past climate conditions, earthquakes, volcanic activity or other environmental phenomena recorded by annual growth rings in old-age trees. Credit: LDEO Archives

While paleo-oceanographers and geologists sift the evidence of Earth's past, others in B&PE monitor the converse: they look at current-day effects of the environment on marine plankton and trees to understand how these organisms respond to changing environmental conditions.

Understanding Earth's Climate Variability

In a paper that appeared in *Science*, Gerard Bond and his coauthors demonstrated that, on centennial time scales, every increase in drift ice volume in the North Atlantic during the last 12,000 years was related to reduced solar output. This research strongly suggests that recurring warm-cold oscillations of interglacial climates, such as those we are experiencing presently, have been partly or entirely linked to changes in solar irradiance. The most recent solar-induced climate cycle is composed of the Medieval Warming Period (MWP, ~A.D. 800 to 1200) and the Little Ice Age (~A.D. 1300 to 1890), and it is highly likely that solar variability will continue to trigger similar warm-cold oscillations in the future.

While some have argued that tree rings cannot provide a reliable indicator of climate change for a period farther back than the year 1200, Edward Cook of the Observatory's Tree-Ring Laboratory and his coauthors have demonstrated that tree rings can preserve multi-centennial temperature trends, if the proper methods of analysis are used. Their reconstruction indicates that the latest 20th-century warming is abrupt and truly exceptional compared to the temperature variations of the past 1,000 years. There is evidence, however, that the Medieval Warming Period was a large-scale phenomenon that appears to have approached, during certain intervals, the magnitude of 20th-century warming, at least up to 1990. Further study should yield important insights into the current global warming trend.

While Cook has developed novel methods of analysis to look further back, and with greater precision, into the climate records of trees, Rosanne D'Arrigo has demonstrated that the warming period of the past does not match the dramatic, sustained warming trend of the past one hundred years. Using tree rings to determine long-term records of factors such as precipitation and water allocation, Gordon Jacoby has also contributed to the establishment of tree-ring laboratories in Mongolia and Russia. Brendan Buckley has expanded climate records to include the tropical regions, particularly pine and teak trees in Thailand, Myanmar and Indonesia. His study of cliff forests, which can remain undisturbed for centuries even when in close proximity to cities, has also resulted in significant climate data.

Reconstructing Earth's Past

Jean Lynch-Stieglitz has combined methods of geochemistry and oceanography to study sediment samples and to reconstruct histories of the ocean climate during, and since, the last ice age. In addition to investigating glacial debris and iceberg movement to see how these were steered by changes in the Larson Ice Shelf (Antarctic Peninsula), Lloyd Burckle, in collaboration with Cecilia McHugh and Steve Pekar, is evaluating the drought record of the Hudson Valley for the past 6,000 years by studying salinity changes in Hudson River sediment cores. Richard Fairbanks has analyzed isotopes in coral skeletons to describe El Niño/La Niña cycles and the Asian Monsoon system, going back thousands of years. Tom Marchitto is working on several projects that involve large-scale climate changes over the past glacial-interglacial cycle, studying regions from the deep Pacific Ocean, coastal Baja California and the Labrador Sea to the North Atlantic.

Understanding Earth's Present

Kevin Griffin studies the mechanics of plant function as part of the forest system. Robert Vaillancourt looks for the responses of phytoplankton in the sea to changes in temperature, sunlight and the availability of nutrients. O. Roger Anderson's research on single-cell organisms, *Protozoa*, demonstrates the dependence of the larger ecosystem on microbial organisms to maintain the system's fertility and energy flow. Chris Langdon has been leading research at Biosphere 2 concerning the metabolism of corals and how it reacts to changes in light availability and carbon levels.

1.

1. Lamont graduate student Allegra LeGrande (far right) and two graduate students from Woods Hole Oceanographic Institution sectioning a sediment core from the Florida margin. Such cores, containing evidence of changes in the strength of the Florida current over the past 10,000 years, help researchers reconstruct the history of the water flow through the Florida straits. Credit: Dorinda Ostermann

2. A crane brings up the multicorer, a machine used by researchers to collect sediment cores, in this instance from the Florida margin. Credit: Dorinda Ostermann

2.

1.

John Marra's reevaluation of the data collected during the Joint Global Ocean Flux Study over the past ten years has led to greater certainty in the measurement of ocean productivity. The most common way of measuring oceanic primary productivity is through the uptake of radioisotopic carbon as bicarbonate—known as the carbon-14 method. Although this method was first introduced over 50 years ago, there has been a longstanding question as to what it actually measured: gross or net production. Marra's research confirms that the carbon-14 method measures net production, allowing scientists to describe more precisely and effectively ocean trends and behavior.

1. Graduate student Will Bowman tracing the area of a stem respiration cuvette he's removed from a podocarp tree in an ancient New Zealand forest. His dissertation project is designed to gain an understanding of the contribution woody tissue respiration makes to the carbon balance of forest ecosystems. Credit: Kevin Griffin

2. Chris Langdon and colleagues use stony corals to research how the rising level of CO_2 in the atmosphere may effect the skeletal growth of corals and other organisms that secrete calcium carbonate skeletons. Research suggests that fossil fuel CO_2 emissions could cause corals to be less able to keep up with rising sea level or to compete for space and light with faster growing algae. The eventual result could be loss of coral reef habitat and the many species that make their homes in reefs. The stony coral (*Diplora strigosa*) pictured here was collected in the Caribbean and has been living in the Biosphere 2 tank for almost ten years. Credit: Raena Cota.

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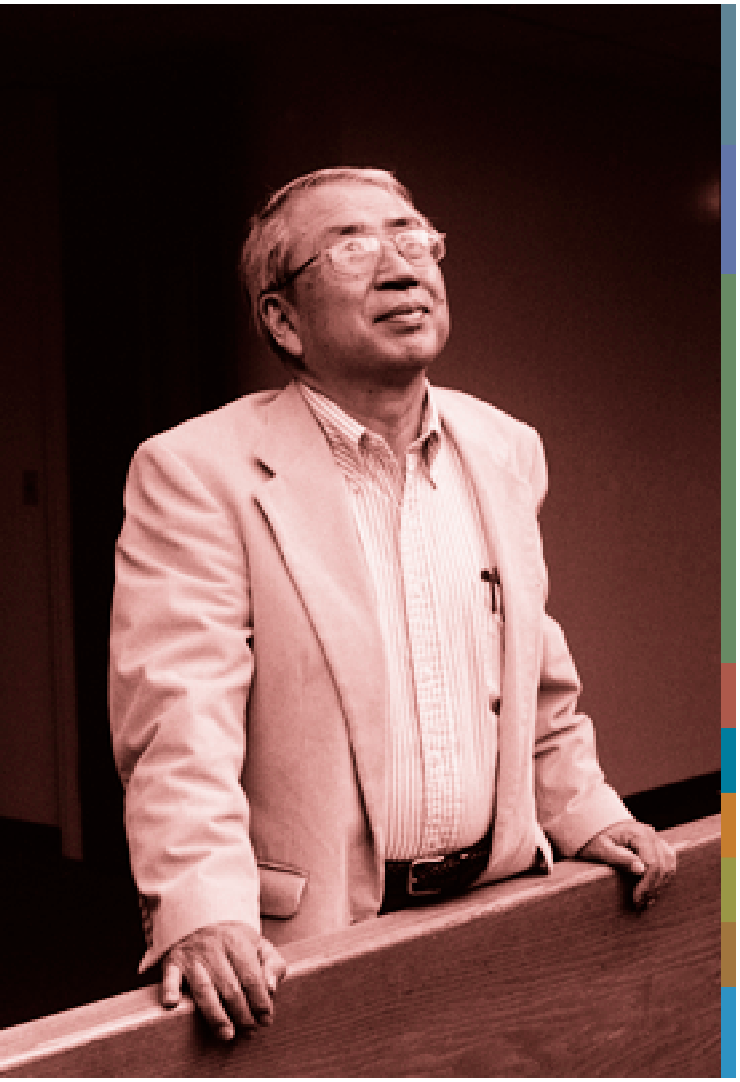

1.

Taro Takahashi, Doherty Senior Scholar
Associate Director, Geochemistry

Researchers in the Geochemistry Division seek to understand Earth's environments by studying its history and the processes that govern Earth's present and past environments. Using advanced chemical and isotope analyses, Division scientists study samples of air, water, biological remains, rocks and meteorites in order to elucidate a broad range of scientific issues. Research topics range from particulate and chemical pollutants emitted by the collapse of the World Trade Center towers on September 11, 2001, to the climate changes of the ice ages, which began some 2.6 million years ago, and the fundamental chemical processes involved in the differentiation and formation of Earth's mantle and core. Observatory geochemists have also contributed greatly to our understanding of socioeconomic issues associated with environmental changes, ranging from contaminated groundwater to the accumulation of industrial carbon dioxide (CO_2) in the atmosphere, which may ultimately be responsible for present day global warming.

Studying Earth's Modern Environments

Industrial Carbon Dioxide and Future Climate: Wallace S. Broecker, one of the world's leading scientists in the field of climate change, suggests that if we continue with our current fossil fuel consumption, we run the risk of triggering major changes in Earth's climate in the late 21st century. Evidence uncovered from the Greenland ice sheet, continental margin ocean sediments and mountain moraines shows that large and abrupt global climate changes during the last Ice Age—as brief as a few decades—were likely associated with sudden reorganizations of the ocean's thermohaline circulation (see next page, Figure 1). Based on current fuel consumption, computer simulations carried out in coupled atmosphere-ocean models predict increased carbon dioxide levels (~750 ppm) for the 21st century—approximately twice today's level—that would cripple the ocean's circulation system.

2.

2. Wallace S. Broecker is Newberry Professor of Earth and Environmental Sciences. He has investigated circulation and material cycles in the global oceans and advanced theories of past and present climate changes. He is a member of the National Academy of Sciences and was awarded the National Science Medal by President Bill Clinton. Credit: LDEO Archives

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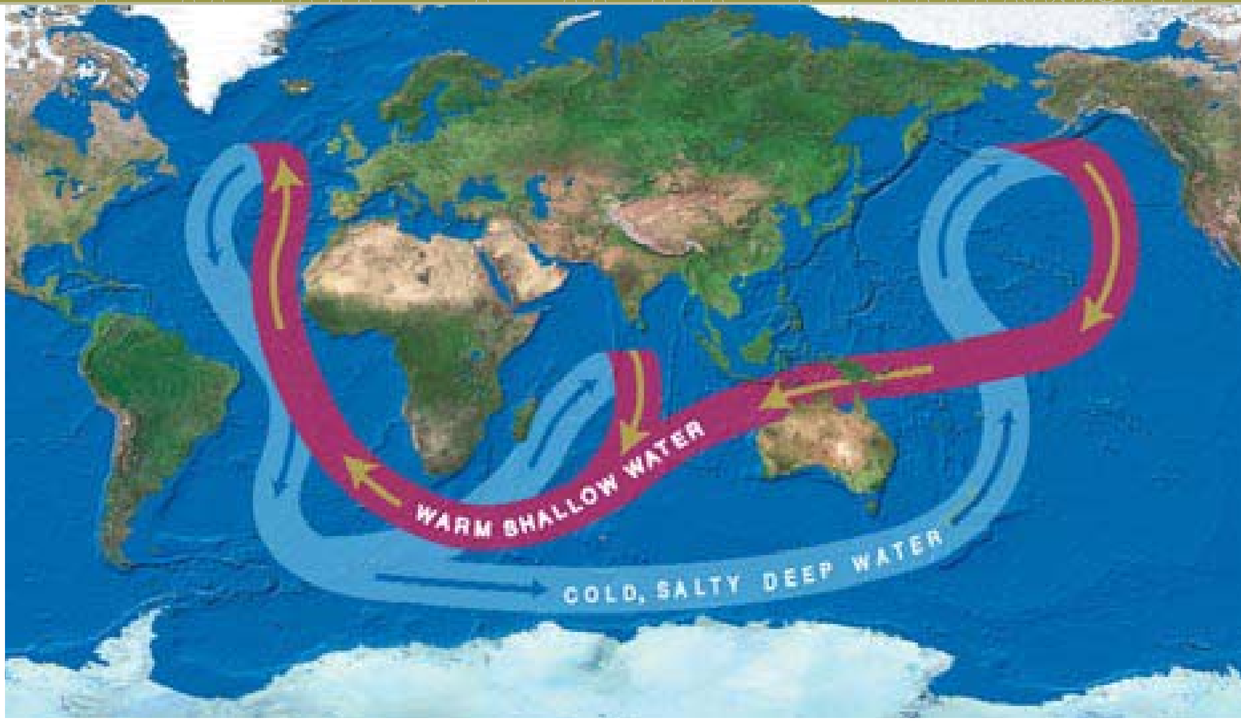
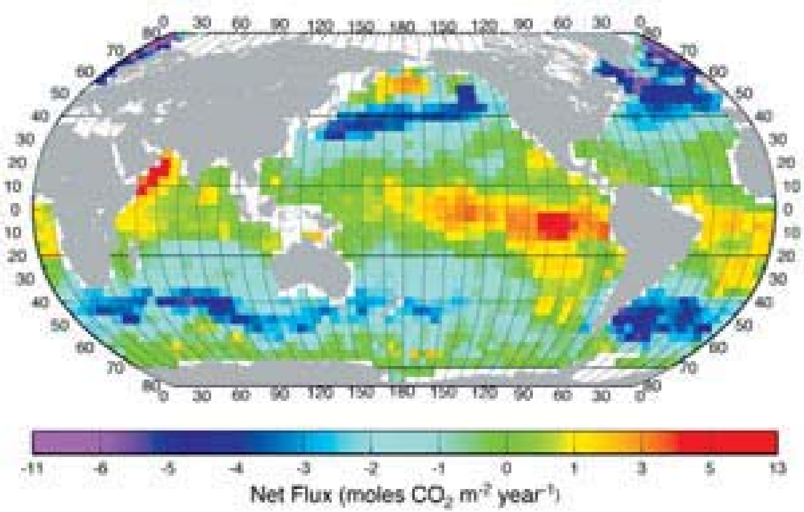


1. The global ocean circulation conceptualized by Wallace Broecker as a "great ocean conveyor belt." In the North Atlantic Ocean, cooled surface waters sink to form the southward flow of deep salty waters transporting and distributing heat, salt and dissolved gases, such as CO_2, to the global oceans. Thus, conditions in the North Atlantic may play a key role in regulating the global climate. Credit: Wallace Broecker

Uptake of Carbon Dioxide by the Global Oceans: About 50 percent of the industrial CO_2 emitted into the atmosphere is being absorbed by the oceans and land biosphere, in approximately equal proportions. Based upon seasonal observations made at sea during the past 35 years, Taro Takahashi and his associates have determined that warm tropical oceans emit CO_2 into the atmosphere, whereas cold high-latitude oceans absorb CO_2 from the atmosphere. In high-latitude ocean areas, spring blooms of photosynthetic plankton play an important role in CO_2 uptake. Observations like these help scientists to understand the physical, chemical and biological processes affecting oceanic uptake of atmospheric CO_2 and whether the global oceans will continue to absorb increasing levels of CO_2 from the air in the future.

Water Circulation in New York Harbor: New York Harbor is one of the busiest seaports in the United States, processing nearly $100 billion in cargo each year. Most of the shipping facilities are located in Newark Bay and the adjoining Kills, which receive a large volume and variety of contaminants, including petroleum, heavy metals, PCBs and dioxins. Peter Schlosser, Ted Caplow, David Ho and associates injected a small quantity of non-toxic sulfur hexafluoride as a tracer into northern Newark Bay to investigate the circulation of water throughout the Bay, the Kills and the tidal portions of the Passaic and Hackensack Rivers. The data obtained over a 12-day period suggest rapid initial dispersion, both laterally and vertically, driven by the tides. Such a study enables prediction of available response time for certain contamination events at various sites, as well as provides critical validation data for computational fluid dynamic models for flow fields of the area. Examples of the Observatory's Hudson River research projects follow on page 38, Rivers and Estuaries Research on the Hudson.

2. Net annual flux of carbon dioxide across the sea surface in 1995. The map represents the mean non–El Niño conditions over a 35-year period (1967–2002) and has been constructed based on about one million CO_2 measurements in surface ocean waters made by Takahashi and his colleagues. The blue-purple areas indicate that the seawater is a sink for atmospheric CO_2, and the yellow-red areas, a source of CO_2 to the atmosphere. Credit: Taro Takahashi



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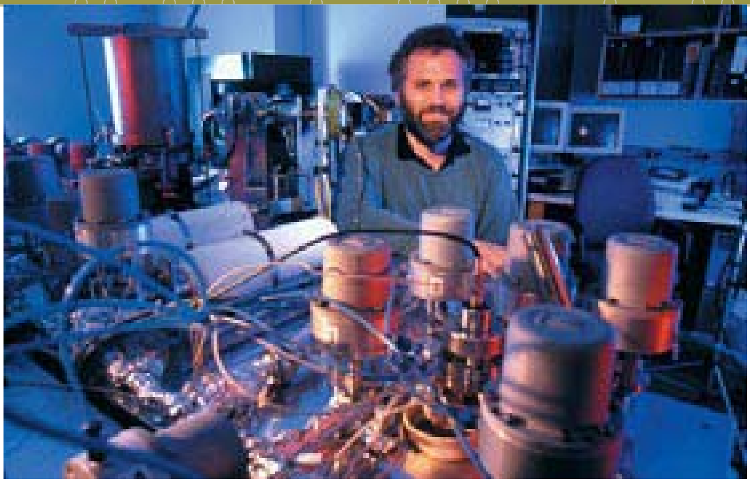
1. Martin Stute is Associate Professor of Environmental Sciences at Columbia's Barnard College. Here, he operates a mass-spectrometer specifically designed for the determination of rare gases such as He, Ne, Ar, and Kr dissolved in groundwater samples.
2. Peter Schlosser is Vinton Professor of Earth and Environmental Engineering at Columbia and Professor of Earth and Environmental Sciences. Here, he operates a special sampling apparatus during a recent cruise in the Hudson River and New York Harbor. Credit: Carlos René Perez



1.

High Arsenic in Groundwaters: Easily accessible sandy aquifers are a convenient source of microbially uncontaminated drinking water for approximately 130 million people in Bangladesh. Sadly, about half of the millions of existing wells do not meet the World Health Organization's guideline for arsenic levels. A team of Observatory scientists that includes Lex van Geen, Yan Zheng, Martin Stute, Roelof Versteeg, Mike Steckler, Peter Schlosser, Jim Simpson and Steve Chillrud is evaluating potential solutions to this crisis by taking into account a complex set of geological, hydrological and geochemical factors. The project was launched by mapping the arsenic content of groundwater pumped by 6,000 hand pumps in a 25 km^2 area of Bangladesh in collaboration with health scientists from Columbia's Mailman School of Public Health. With these studies scientists hope to find ways to reduce existing arsenic levels and to prevent future contamination of groundwaters at risk worldwide.

2.

Contaminants in Urban Air: Steven Chillrud, in collaboration with public health scientists from Mount Sinai Medical Center and Columbia, Harvard and Johns Hopkins Universities, is investigating airborne toxic exposures. He has developed various sampling equipment including portable, battery-driven sample collectors for fine airborne particles, and collected samples in Los Angeles and in New York City—including lower Manhattan during the year following the collapse of the World Trade Center towers as part of an ongoing study at the site. In a series of school-based studies in lower Manhattan, high school students were asked to carry these collectors. These studies have shown that concentrations of several metals from steel dust were more than 100 times greater in the subway system than above ground. For those New York City high school students who ride the subway, the normal daily commute to school provides 70-90 percent or more of their total airborne exposure to iron, manganese and chromium. Work is currently planned to investigate whether there is any potential for bad health effects from these exposures.

Studying Earth's Paleo Environments

Past Climate and Deep Ocean Circulation: The strength of the North Atlantic Deep Water circulation, which represents a starting point of the global ocean conveyer circulation, may have changed during and through the last deglaciation period. Alexander Piotrowski, Steve Goldstein and Sidney Hemming investigated using neodymium isotope ratios in iron-manganese components found in deep ocean sediments taken from the Cape Basin in the southeastern Atlantic Ocean. Their data indicate that the North Atlantic Deep Water circulation began to become stronger 18,000 years ago—about 3,500 years prior to the Bolling Warming Period recorded in Greenland ice cores. The circulation weakened during the Younger Dryas period (~9 thousand years ago) and strengthened to early Holocene maximum. These findings suggest that the major climatic changes of the past were closely coupled with changes in the global ocean conveyor circulation (see page 11, Figure 1).

1. Core RC11-83, taken from the Cape Basin in the southeast Atlantic. Black arrows show the pathway of North Atlantic Deep Water (NADW). White arrows show the movement of Antarctic Bottom Water underlying NADW. By studying neodymium isotope ratios in the core, scientists Piotrowski, Goldstein and Hemming documented changes in NADW circulation during past ice ages. Credit: Steve Goldstein
2. The concentration of iron (Fe) (vertical axis) and manganese (Mn) (horizontal axis) in particulate samples collected in lower Manhattan. Long-term exposures to manganese pose potential risks for neurodegenerative disease. Short-term exposures to high iron and manganese concentrations in the air might also be of concern for those with cardiovascular and respiratory illnesses. Credit: Steven Chillrud
3. Division scientist Pierre Biscaye and one of several colleagues who are studying the Hipparion Red-Earth Formation in northern China, looking for clues to climate changes that occurred millions of years ago.

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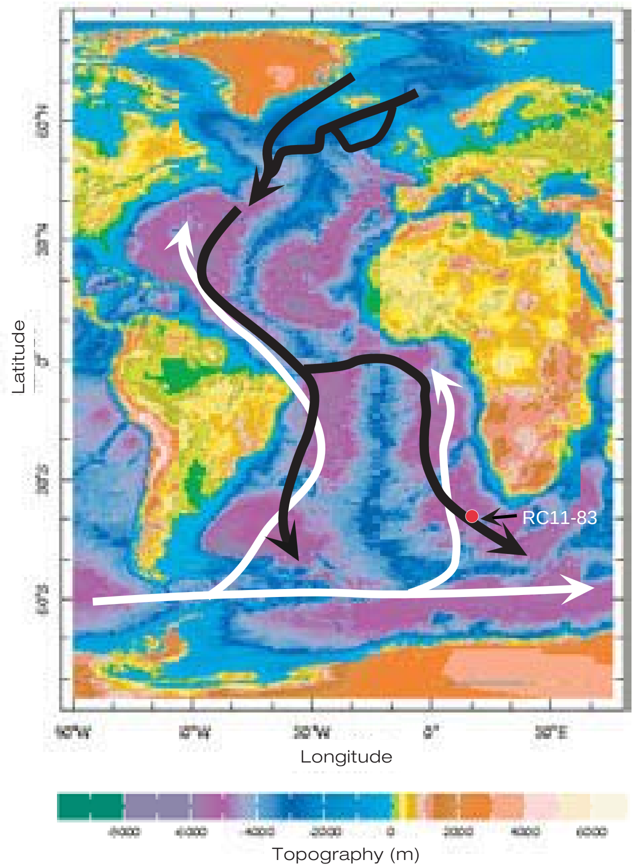
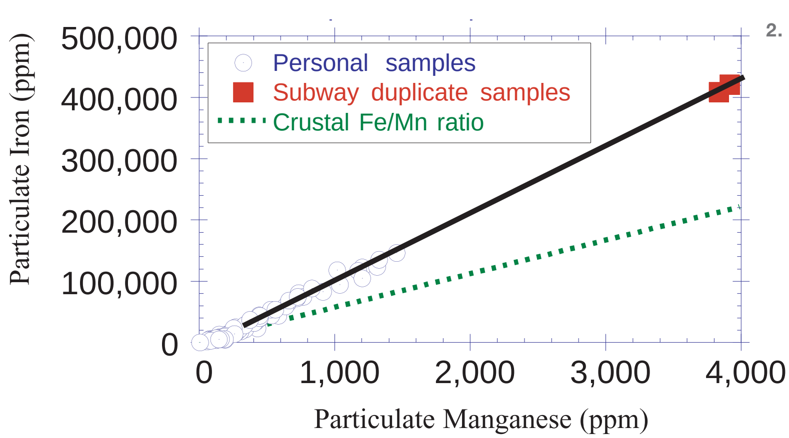


Documenting Climate Change 7 Million Years Ago: In the middle reaches of the Yellow River in northern China, under the well-known Loess-soil sequences of the last 2.6 million years, is the Hipparion Red-Earth Formation, a major part of which is of wind-blown origin. Since the eolian dust deposited in this region originated from the Asian desert lands, Pierre Biscaye and his Chinese associates believe that the Red-Earth must contain a record of the aridification history of the Asian interior during late Miocene-Pliocene time. Their studies have revealed that intense eolian dust deposits began ~6.2 million years ago at the central Loess Plateau, indicating that sizable desert lands in the interior of Asia were formed by that time. They also noted an intensification of eolian deposits at ~3.6 million years ago, at about the same time as a suggested major uplift of the Tibetan Plateau. Their general aridification history is also consistent with the ongoing high-latitude cooling and consequent expansion of Arctic sea-ice/ice sheets during this interval. These findings suggest that both Tibetan uplift and ice-building processes in the northern hemisphere were prominent driving forces behind the long-term desertification in the interior of Asia.

Ground Waters and Past Climate of Continents: Martin Stute, Peter Schlosser and colleagues investigated the aquifer within the Aquia formation in southern Maryland and discovered that the ground temperature during the last glacial maximum 21,000 years ago was about 9ºC colder than the postglacial period. Concentrations of dissolved atmospheric noble gases give a means for estimating average annual ground temperatures at the time of infiltration. Since some aquifer waters were isolated from the air many thousand years ago, the estimated ground temperatures derived at these sites yield important information about climate and climate variability in the past.

Studying Earth's Interior

Chemical Reactions between Earth's Mantle and Core: Earth's core-mantle boundary consists of a highly heterogeneous metal-oxide interface subjected to high temperatures, pressures and a varying electrical field generated by Earth's outer core. Abby Kavner and David Walker have developed a method for measuring the electrical behavior of metal-silicate interfaces at high pressures (15–25 kbar) and temperatures (1300–1400ºC). Their studies have revealed a rich array of electrical and electrically activated chemical behavior and have advanced our understanding of the chemical reactions important to the evolution of Earth's mantle and core.



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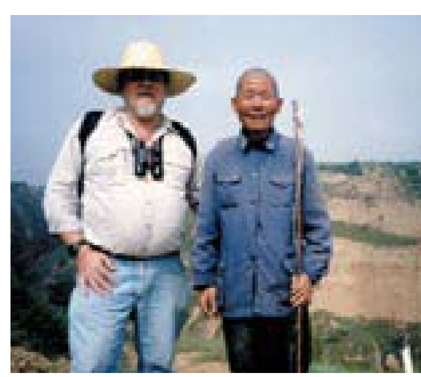

Marine Geology and Geophysics

1.

Jeffrey K. Weissel, Doherty Senior Scholar
Associate Director, Marine Geology and Geophysics

More than 50 years after Columbia University seismologist Maurice Ewing set out to explore the world's ocean floors by studying the elastic waves from earthquakes and man-made explosions, scientists in the Marine Geology and Geophysics (MG&G) Division have charted more than 3 million miles in the Observatory's three research vessels as they conduct research in all of the world's oceans.

Observatory scientists have always been in the vanguard of ocean research. New tools, such as Multichannel Seismic Reflection techniques, now allow researchers to probe more deeply into Earth, and multibeam bathymetry mapping and side-looking sonar imaging instruments, some pioneered here at the Observatory, permit scientists to map larger areas of the seafloor, in ever greater detail. Using a "free swimmer" or Autonomous Underwater Vehicle operating 20 m above the seafloor in depths of 2,600 m, MG&G scientists Marie-Helene Cormier and Bill Ryan, and their colleagues from Woods Hole Oceanographic Institution and the University of Hawaii, were able to map fresh lava flows along the East Pacific Rise in unprecedented detail (2.5 m "footprints") (see page 15, Figure 1).

Over the years, the Observatory's Borehole Research Group (BRG) has made major contributions to scientific ocean drilling, using down-hole geophysical measurements of the well-bore material to investigate the history of global sea level variations, to measure the flow of fluids through fractured rock of the ocean crust, and to determine the thermal and mechanical properties of the ocean's crust and upper mantle. Through the Joint Oceanographic Institutions Inc., BRG is currently charged by the National Science Foundation with providing logging services to the foundation's Ocean Drilling Program (ODP), as well as with developing new types of borehole logging instruments, adapting oil field logging tools and maintaining a data base of all

2.

2. Sally Odland, Division Administrator (left) and Tania Drinnon, Administrative Assistant (right), the MG&G administrative staff.

3. Multichannel seismic profiling produces enhanced images of the crust by combining sound reflections recorded by many receivers. The research vessel tows air guns and a long "streamer" containing a string of hydrophones grouped into receiver channels. Each channel records sound reflected by the seafloor, as well as sound refracted by the seafloor and then reflected by underlying rock layers.

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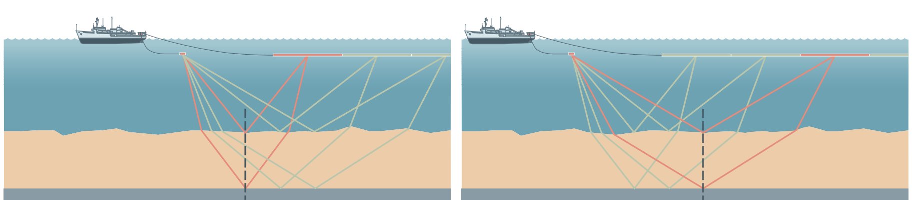

logging measurements on behalf of the ocean drilling community worldwide. In the transition from the ODP to a new, more integrated ocean drilling program, with its more complicated international partnerships and its multiple drilling platforms, MG&G is well-positioned to play an even larger role in the ocean drilling science of the future.

Research Highlights

Methods are urgently required to control and/or mitigate the increase in atmospheric carbon dioxide (CO_2), which although a minor component of the atmosphere, is thought to be primarily responsible for global warming. In a two-year pilot project, David Goldberg, Taro Takahashi and others have been investigating methods for CO_2 sequestration in underground aquifers. By studying the permeability and hydrogeological characteristics of the sedimentary and igneous rock layers present in a well drilled on the Lamont campus, and the chemical reactions between CO_2 and the host rock, these researchers are aiming to develop ways of determining the amount of CO_2 that can be stored in land rock formations. Similar experiments are planned to study CO_2 sequestration in the ocean crust, as well as at numerous land-based sites in conjunction with ongoing efforts by other U.S. labs.

The world's mid-ocean ridges are not only places where new ocean crust is continuously created, but are sites of unique biological communities sustained by heat energy and nutrients brought to the seafloor in hydrothermal circulation systems. In July of 2002 Suzanne Carbotte led an expedition aboard the Observatory's R/V *Maurice Ewing* to image the crustal structure of the Juan de Fuca Ridge in the northeast Pacific Ocean. The Juan de Fuca Ridge has been studied since the development of the theory of plate tectonics in the 1960s; however, prior to this expedition little was known about the magma chambers, which provide the heat source driving these hydrothermal systems, or about the structure of the shallow crust through which seawater and heat circulate. Using the multichannel

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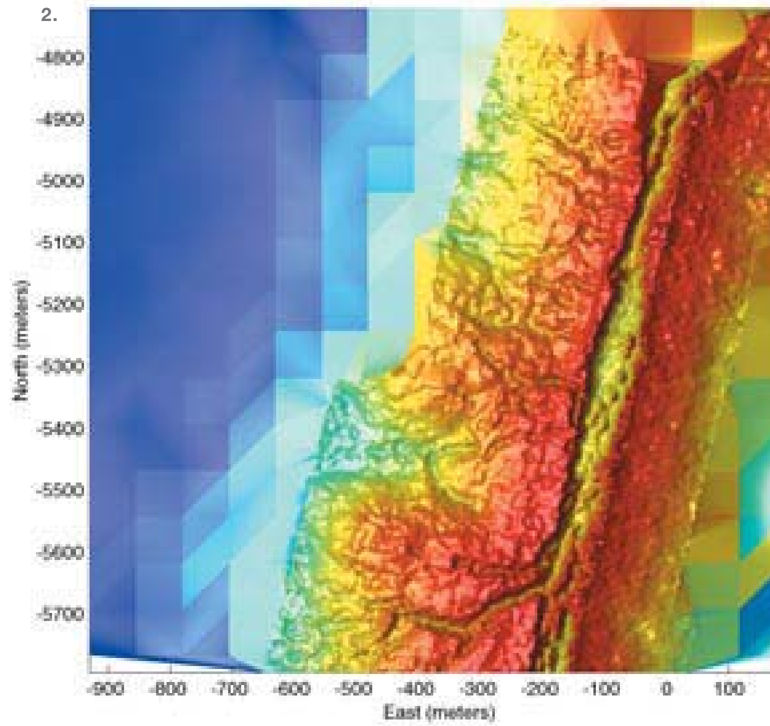

1. This high-resolution micro-bathymetry map of the axis of a mid-ocean ridge in the southeast Pacific was produced using the Autonomous Underwater Vehicle "ABE," which operated only 5-10 m from the seafloor at a depth of 2600 m. The map highlights subtle volcanic features, including a narrow, 10 m deep eruptive fissure at the very summit of the mid-ocean ridge (center) and numerous lava channels running down from that fissure. Red indicates a shallower seafloor. Credit: Dana Yoerger, Woods Hole Oceanographic Institution.

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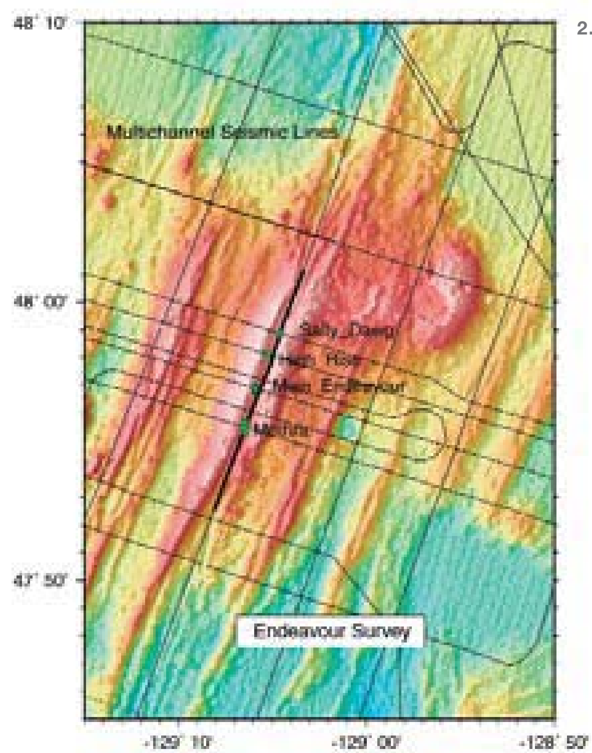
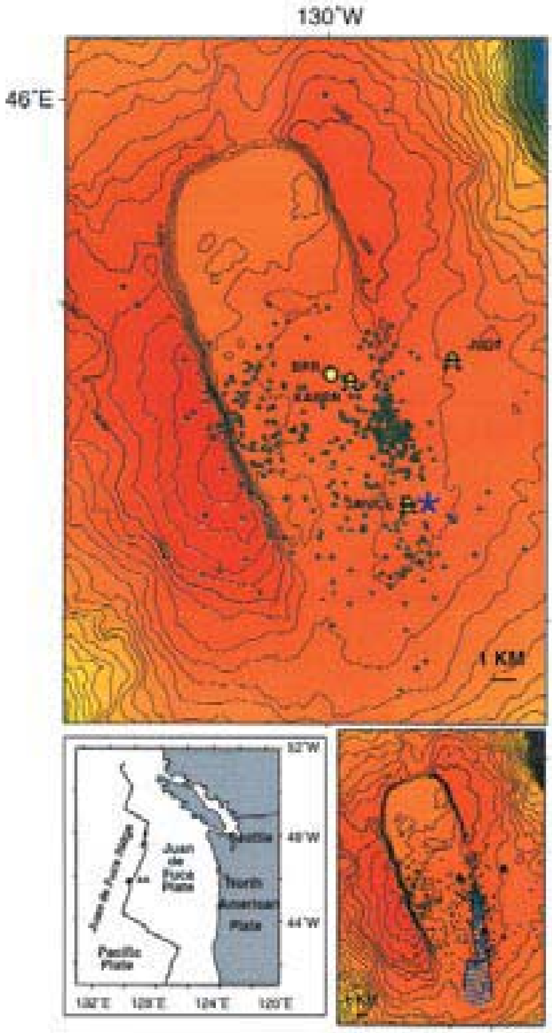


2. Bathymetry map of the Endeavour Ridge located off the coast of Vancouver. Black lines show locations of multichannel seismic tracks. Hydrothermal vents along the crest of the Endeavour Ridge are shown in green squares. Suzanne Carbotte and colleagues used seismic studies to determine the internal structure of the crust at this mid-ocean ridge and found that magma chambers are closely associated with the hydrothermal vents along the axis (labeled sites). Credit: Suzanne Carbotte



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seismic system aboard the *Ewing*, Carbotte, John Diebold and their colleagues from Woods Hole Oceanographic Institution and Scripps Institution of Oceanography found extensive magma chambers located 2.5 km below the seafloor along much of this ridge, including sections of the ridge where magma chambers were previously believed to be absent. These new data indicate that the potential for volcanic eruptions is high along much of this ridge and that disruptions to the hydrothermal systems from magmatic events is expected. The data collected will permit scientists to study how the oceanic crust changes with percolation of seawater through the crust and will provide important baseline information on the structure of the crust for a wide range of ongoing and new initiatives.

The ocean is full of acoustic energy generated not only by earthquakes but by the tremors associated with volcanic activity as well. While studying these data for information about seafloor volcanism and tectonics, Maya Tolstoy and Del Bohnenstiehl discovered that seafloor earthquakes on a volcano off the coast of Oregon were being triggered by the tides. Tidal correlation of earthquakes on land has been hard to prove, but this seafloor experiment shows the strongest statistical evidence to date for tidal forcing of volcanic activity. In a related study, they revealed that the magma forming a large seafloor eruption under the Arctic ice may have come directly from Earth's mantle. The Arctic Ocean floor is known to have very thin crust, and seismicity associated with the eruption indicates that the magma originated from depths below the base of the crust.

Rapid response is key to saving lives and assessing property damage when natural disasters strike.

2.

1. Ocean floor earthquakes (brown dots) detected by three ocean-bottom seismographs and the National Oceanic and Atmospheric Administration–Pacific Marine Environmental Laboratory's bottom-pressure recorder (BPR), which recorded the tides. Lower right figure shows outline of 1998 flow compared with location of 1994 seismicity. Lower left figure shows the location of an axial volcano (AS=Axial Seamount) on the Juan de Fuca Ridge, off the coast of the northwestern United States. Credit: Maya Tolstoy
2. Del Bohnenstiehl (left) and Maya Tolstoy (right) at sea analyzing data from an Arctic volcanic eruption. Credit: D. K. Smith
3. Acoustic image of the Tappan Zee Reach of the Hudson River based on data collected by Observatory scientists. East-west trending dark bands represent newly discovered oyster beds. The green dots mark locations of core samples that provide researchers with insights into the changing nature of the river.

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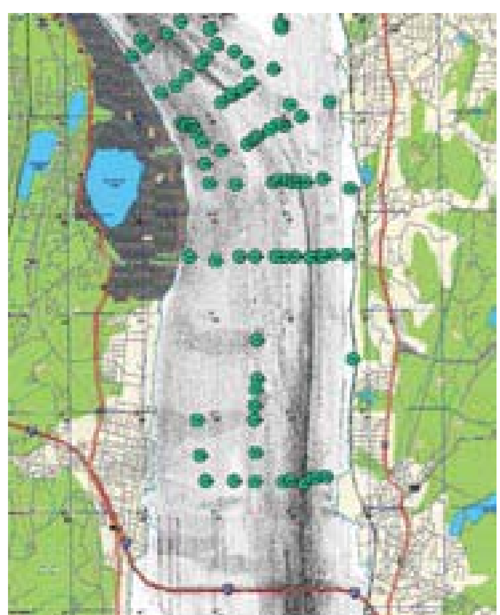

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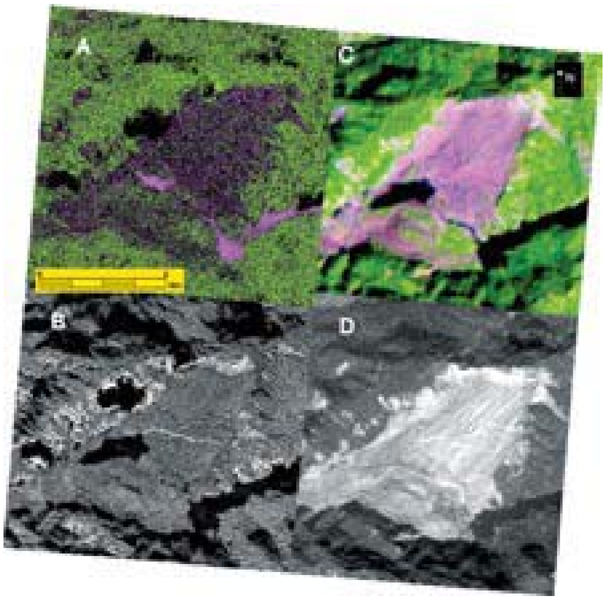

Darkness, clouds or smoke over devastated areas can delay urgent relief efforts. Radar is not hampered by these conditions and can provide the needed information in a timely manner. In one of a suite of new programs conducted under the auspices of the Center for Hazards and Risk Research, Jeffrey Weissel, Kristina Czuchlewski and colleagues at NASA's Jet Propulsion Laboratory are developing radar-based approaches for rapid response to natural disasters. Hazards such as floods, fires, volcanic eruptions and landslides essentially "re-surface" parts of the terrain and, in doing so, alter the dominant radar scattering properties of the areas affected. The overall goal is to develop radar-based systems that can be deployed for rapid assessment of the extent and severity of many different kinds of natural disasters. Examples of the Hazard Center's multifaceted research projects follow on page 42 (Managing Risk in an Uncertain World).

Using high-resolution sonar mapping tools developed for ocean exploration, Robin Bell and colleagues have surveyed the Hudson riverbed from the Federal Dam at Troy to the Verrazano Bridge. This basic mapping activity is essential to research on a wide range of river issues, including sediment and contaminant transport, carbon and nutrient cycling, and the effects of global climate change. Human impacts complicate natural processes but must be well understood if scientists and local leaders are to institute wise stewardship of the Hudson in the face of mounting pressure from development and increasing population. Examples of the Observatory's Hudson River research follow on page 38 (Rivers and Estuaries Research on the Hudson).

1. Comparison of various types of remote sensing data over the Tsaoling landslide within 18 mos. of the Sept. 1999 Chi Chi earthquake (magnitude 7.6) in central Taiwan: A. Surface classification map made from radar scattering mechanisms; B. Grayscale C-band image of vertically polarized backscatter SAR Intensity; C. False-color image of Landsat 7 Thematic Mapper (TM) data; D. Indian Research Satellite visible band panchromatic data obtained six weeks after the landslide. The landslide is the light colored area and the vegetated slopes are dark. Credit: Jeff Weissel
2. At-sea transfer of personnel onto the ODP drill ship JOIDES *Resolution*, at Hydrate Ridge off the coast of Oregon. The Observatory's Borehole Research Group conducted extensive wire-line logging and Logging-While-Drilling operations to investigate the *in situ* properties of natural gas hydrates. Credit: Gilles Guerin
3. Observatory scientist Michael Studinger (left) discusses the airborne geophysical survey and other Observatory research activities with the Russian station manager Alexander Kondratjev (middle) and the Russian physician Vassili Lutsiv (right) in a tent near Vostok Station.
4. Signpost at Vostok Station, Antarctica. Antarctic signposts are an old tradition and can be found at every research base. The signs show direction and distance to the hometowns of people who have spent a winter in Antarctica.

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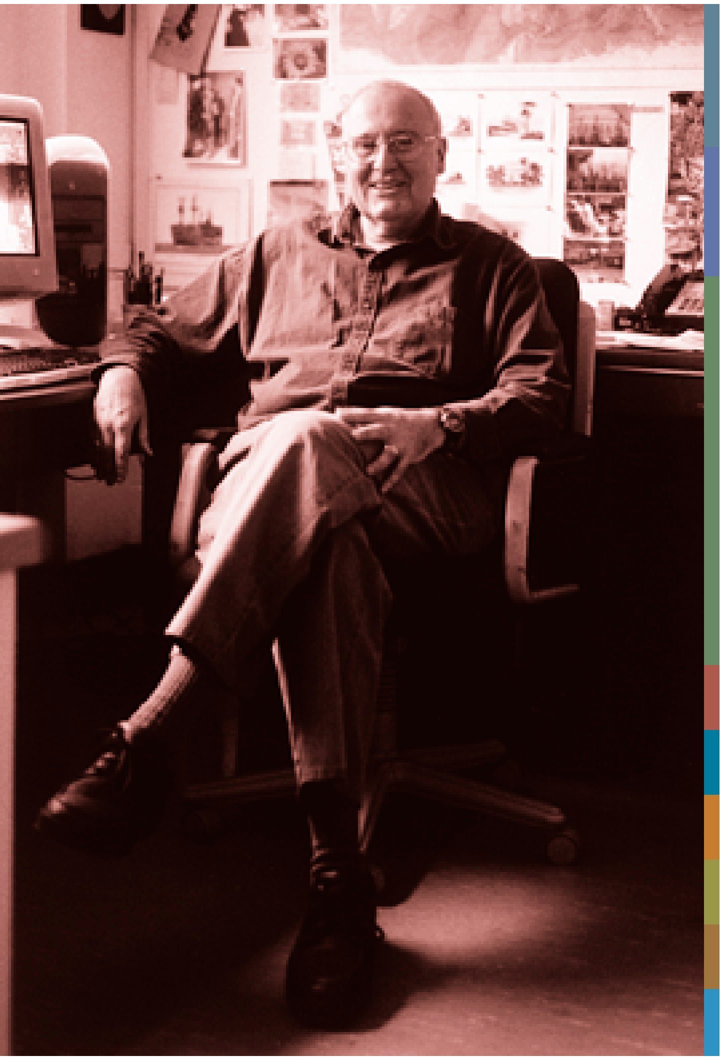


1.

Arnold Gordon, Professor of Earth & Environmental Sciences
Associate Director, Division of Ocean and Climate Physics

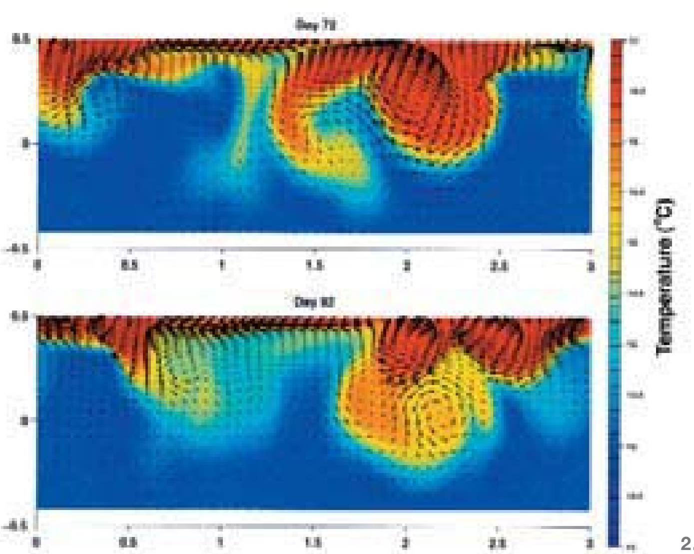
Scientists in the Division of Ocean and Climate Physics (DOCP) delve into the mysteries of Earth's climate in order to document climate change and build an understanding of its controlling forces. Climate change is a crucial factor that has influenced human history over the ages. Reliable prediction is essential to humankind's future and to the well-being of the planet.

The Division's main research objective is to gain better understanding of the ocean and atmosphere and to hone predictive skills. DOCP researchers strive to understand the forces and processes that shape ocean and atmosphere structure and circulation, and ocean and atmosphere interactions and their effects on climate and climate variability. Researchers particularly stress regional and global ocean and climate variability from interannual to centennial time scales, as well as the underlying physics associated with abrupt climate change indicated in paleoclimate records.

DOCP scientists conduct research through observations, a hierarchy of numerical simulations and application of fundamental geophysical fluid dynamics. They derive their observations from a variety of sources: some obtained during seagoing investigations, others from archived and satellite-derived data. Data generated through a combination of observations and numerical models are increasingly important in portraying the full spectrum of spatial and temporal variability of the ocean and atmosphere. Close collaboration between observationalists and modelers, oceanographers and climatologists, and with scientists from other divisions, notably those within Geochemistry, is a hallmark of the Division and has led to significant advancements in the field of ocean and climate science.

Climate Modeling

The Division includes a premier climate modeling group. Begun in the 1980s with a focus on predicting El Niño through a simple ocean/atmosphere model, the group's success ultimately led to the establishment of the world-renowned International Research Institute for Climate Prediction. Today, DOCP modeling efforts have expanded and are producing increasingly realistic ocean and atmosphere models on a global scale. Recent research by Dr. Richard Seager and colleagues has shown that the Gulf Stream actually has little effect on the contrast in



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2. Computer model simulation of a bouyant (warm water) jet. The model runs were performed by Naomi Naik, Martin Visbeck and Dick Ou as part of a project that investigated the formation of ocean eddies. The figure shows two snapshots of surface temperature (color) and ocean surface velocity (arrows) in a reentering channel configuration 100 km in width and 300 km in length. Credit: Martin Visbeck

1. Panel (A) illustrates the movement of heat by ocean currents, while Panel (B) simulates climate, when heat by ocean currents is set to zero. Note the similarities between the two. Research by Richard Seager and colleagues has revealed that differences in winter temperatures between western Europe (warm) and eastern North America (cold) are not caused by heat transport by the Gulf Stream, dispelling a long-held assumption to the contrary. Credit: Richard Seager

2. Technicians tethered with safety lines brave high swells during a mooring recovery in the northwest Weddell Sea. Researchers, such as Division scientist Phil Mele, use an array of moorings to measure the circulation of the Weddell Sea. Credit: Stacey Robertson

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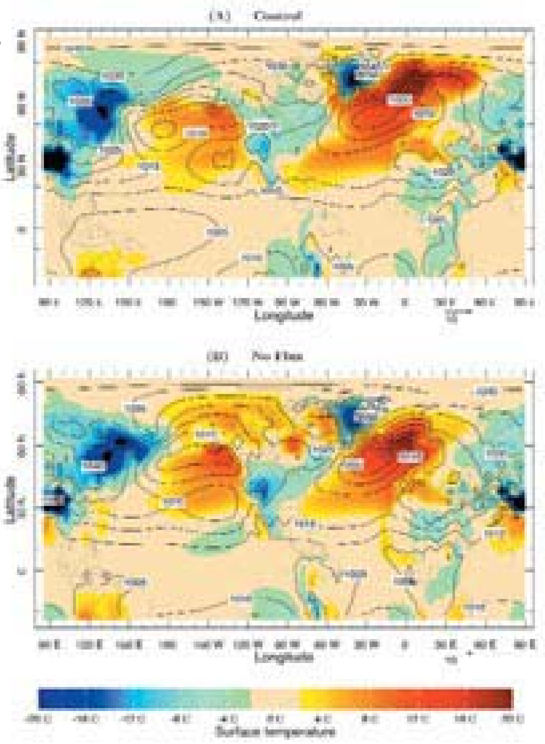

Deviation from Zonal Mean Values:
Sea Surface Temperature (colors) Sea Level Air Pressure (contours)

winter temperatures between Europe and eastern North America. Dispelling a long-held assumption, their research instead suggests that atmospheric circulation, augmented by the Rocky Mountains, plays a larger role. Analogous to an island in a stream, the Rockies set up a persistent wave in the winds downstream that brings cold winds from the north into eastern North America and warm winds from the south into western Europe. This pattern of heat movement by the winds accounts for half the total difference in winter temperatures between the two regions, while much of the other half can be attributed to the release of heat stored in the ocean.

Division researchers use atmosphere and ocean observations to document the spatial and temporal scales of climate variability, such as those directly linked to El Niño, the Arctic and Antarctic Oscillations and the North Atlantic Oscillation, as well as to the slow changes of temperature that may be associated with man-made factors, such as increased levels of greenhouse gases. For example, Martin Visbeck and Gerd Krahmann have advanced our understanding of the Atlantic Ocean and Arctic sea-ice response to changes in surface winds associated with the North Atlantic Oscillation. Visbeck and Krahmann have found a clear relationship between sea-ice drift and thickness distribution in the Arctic Ocean, but a more

2.

1. Deployment of a mooring in the northwest Weddell Sea. Division scientist Gerd Krahmann is seen here attaching an instrument onto the mooring cable that will allow researchers to take temperature and conductivity measurements, which are then used to calculate water salinity and pressure. Credit: Phil Mele

1.

complex relationship of sea-ice in the Greenland/Iceland Seas, which may have possible implications for the global ocean's thermohaline circulation.

In another study, Xiaojun Yuan and Douglas Martinson recently described the Antarctic Dipole—an interannual oscillation in the southern polar oceans that is characterized by a seesawing relationship in both ice volume and temperature anomalies between the Pacific and Atlantic sectors of the Antarctic. Their research shows that this high latitude climate mode of variability is closely associated with El Niño–Southern Oscillation (ENSO) variability in the tropics through atmospheric connections. Such findings ultimately may help scientists to discern whether ENSO, whose global impact on the climate system is well known, plays a governing role in the Antarctic Dipole Oscillation or is instead governed by it.

Ocean Research

Ocean field research ranges from the Indonesian seas to the icebound polar regions of the Southern Ocean and Arctic Seas. Division researchers also carry out field activities in the less extreme environments of the South and North Atlantic and Indian Oceans. Through this fieldwork, researchers aim to integrate regional oceanography into a better understanding of the global ocean system and the relationship of the ocean to climate change. A challenging field activity by Arnold Gordon, Martin Visbeck and Stan Jacobs is designed to study the processes that control the escape of dense water from the continental shelf of Antarctica—which ultimately chills the lower 2 km of the world's ocean—and are poorly represented by current global and regional models. Building robust model representation requires a firm grasp of the physical dynamics, and Division oceanographers remain in the vanguard.

In a recent study, Arnold Gordon examined the transfer of mass, heat and fresh water between the major oceans. Interocean exchange provides pathways for the transfer of heat and fresh water and associated anomalies between oceans, which may play an important role in shaping global climate patterns and variability. The present focus of this work, carried out with R. Dwi Susanto and Amy Ffield, is the study of the transfer of warm Pacific water to the Indian Ocean through the complex passages of the Indonesian seas, otherwise known as the Indonesian Throughflow. The Throughflow plays an integral part in the global thermohaline circulation and is believed to be a key element in such climate phenomena as ENSO and the Asian Monsoon. An ambitious three-year program of measuring the Throughflow, in collaboration with Indonesia, The Netherlands, France and Australia, is scheduled to begin in early 2003.

2. Panel (a) shows the relationship of winter surface temperatures and surface air pressure with the phase of the North Atlantic Oscillation (NAO). Cold (blue) colors mark regions where winter mean temperatures are colder during the positive phase of the NAO, while warm colors (yellow-red) highlight regions with warmer temperatures; Panel (b) shows the value of the NAO index (defined as the sea level pressure difference between Iceland and the Azores) from 1850 to 2002. Division scientists have been instrumental in documenting the impacts of the NAO on climate in the Atlantic sector, including its effects on the circulation of the ocean, snow cover over the eastern United States and energy usage in Scandinavia. Credit: Martin Visbeck

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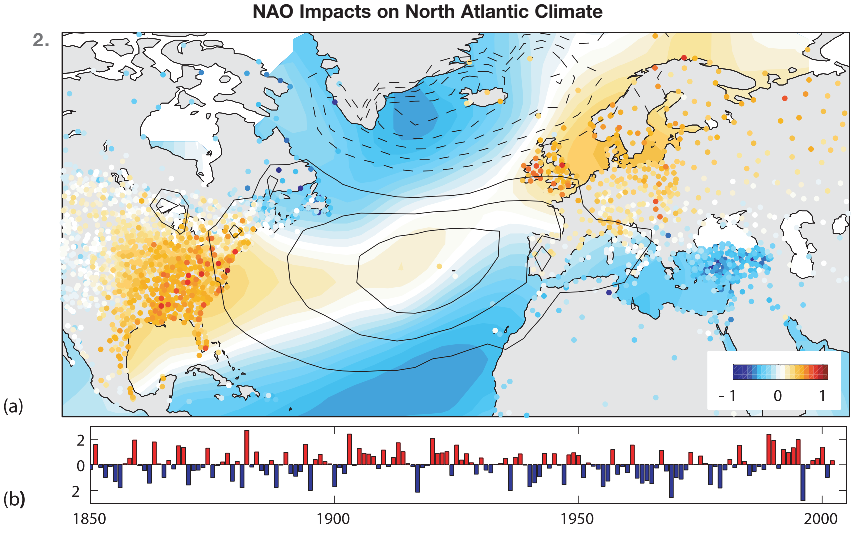

1. Off the New England coast, a harmless dye tracer was injected near the foot of the shelfbreak front, which separates cold, fresh shelf water from warm, salty slope water. Red shows where the dye's concentration was highest, near the shelfbreak on the New England shelf, south of Martha's Vineyard. Arrows show the dye's trajectory across the front as it disperses along constant density surfaces (solid lines) over seven days. White lines represent the tracks of the towed instrumentation that collected the data. Credit: Robert Houghton

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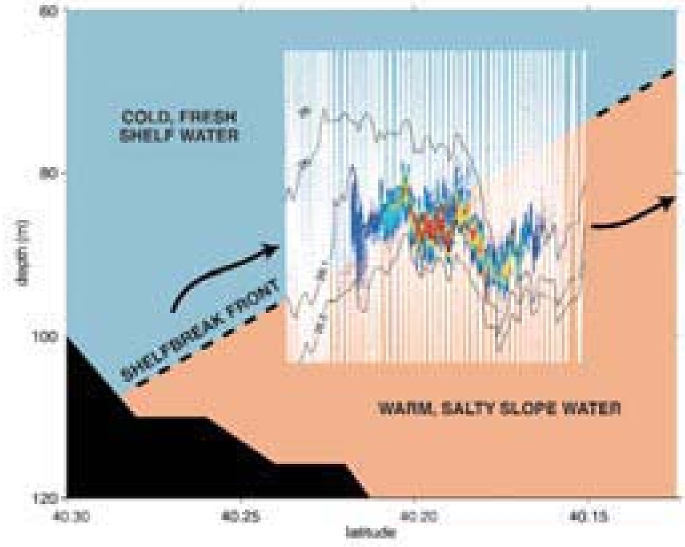

Local Coastal and Estuarine Waters

Researchers within DOCP are increasingly involved in local coastal and estuarine waters, such as the Hudson River, Jamaica Bay and the neighboring coastal ocean. Robert Houghton developed and applied an innovative way to quantitatively measure the circulation and mixing processes across the boundary that separates the shallow shelf waters from those of the open ocean. The objective is to understand the physical processes responsible for the enhanced biological productivity at the outer edge of the shelf. Skillfully tracking a cloud of a fluorescent dye tracer introduced at the edge of the continental shelf south of Martha's Vineyard as it swirled amid the energetic tidal and regional currents, Houghton measured the evolution of the dye cloud, exposing the subtleties of the mixing and circulation processes responsible for bringing nutrient-rich water needed to sustain characteristic high biological productivity.

In another study, Houghton and Martin Visbeck applied these same techniques to determine the physics of the Hudson's salt wedge to better understand the forces that control the upstream intrusion of ocean salt into the Hudson River. Since the circulation of the river system influences the ecosystem as well as the removal of contaminants from the Hudson, understanding of the river and estuary structure is critical to improved management of the river's resources. In a related project, Visbeck and Bruce Huber established a monitoring system of Hudson River properties, such as salinity and velocity, at the end of Piermont Pier. Sensors set at different points along the river now record the continuously changing nature of the river. By collecting and analyzing this data, Division scientists hope to gain further insight into the nature of the river and its surroundings.

Division research also includes study of hydrological processes related to climate changes. Marc Stieglitz and his group are studying the complex interplay of rivers and the biogeochemical processes that help shape the surrounding landscape. His group's research has led to a fundamentally new way of conceptualizing hydrologic processes within climate models and to an enhanced understanding of the mechanisms responsible for the sudden initiation of a downslope flow of fresh water into lower-lying valleys.

What is climate change?

To achieve a relatively steady climate, Earth's ocean and atmosphere must transfer heat and freshwater around the globe to compensate for varying radiation and regional differences between precipitation and evaporation. How these fluids work independently and as a team to accomplish their task over Earth's varied land-ocean configuration sets the climate pattern on the planet. They do their job well for Earth has a reasonably stable climate, but climate change does occur and civilization is increasingly vulnerable to such change.

Fluctuations in solar radiation and Earth's volcano activity, as well as changes within the ocean and atmosphere, as they interact with one another, lead to an array of climate variations and adjustments over time. A key feature of climate is the abundance of water, which acts to lessen climate extremes. Varying amounts of greenhouse gases (such as water vapor, carbon dioxide, methane) also can significantly alter the ability of the atmosphere to rid itself of heat. Understanding natural climate variability is complicated enough, but there is also the perplexing issue of the increasingly powerful effects of humankind superimposed on this natural variability.

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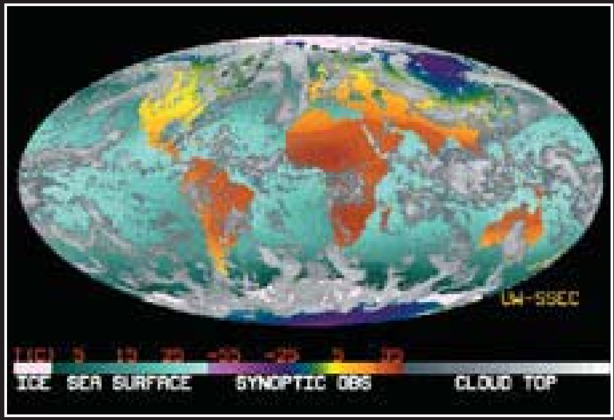


2. A snapshot of Earth. Land and sea surface temperatures as well as ice and existing clouds on November 8, 2002. Credit: Space Science and Engineering Center, University of Wisconsin, Madison

1.

Art Lerner-Lam, Doherty Senior Research Scientist
Associate Director, Seismology, Geology and Tectonophysics

The more than 50 staff and students who comprise the Seismology, Geology, and Tectonophysics (SG&T) Division are part of a long tradition in the solid Earth sciences at the Observatory. SG&T researchers have always been in the forefront of theoretical and observational seismology, rock mechanics, structural geology and tectonics, and sedimentary geology and have made lasting contributions to the study of earthquakes, the structure of Earth's crust, mantle and core and the large-scale motions and deformation of the plates. SG&T scientists also serve the nation and world by pursuing applied research in two critical areas: reducing the vulnerability of society to natural hazards and verifying international treaties governing nuclear weapons testing.

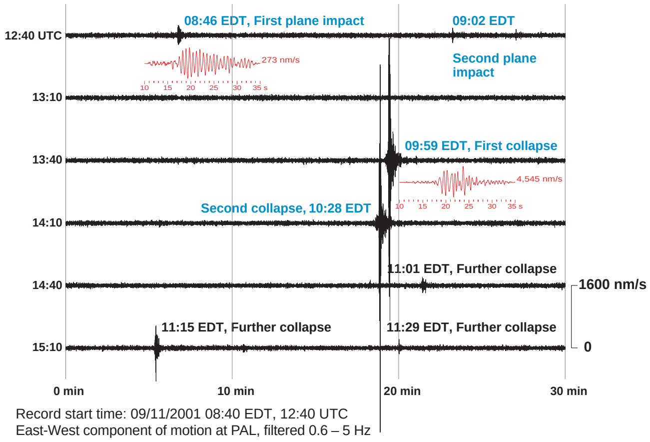
This research and service ethic continues today with expanding multidisciplinary investigations and an increasing number of collaborations with governments and research institutions around the world.

The Lamont Cooperative Seismic Network

Technical innovation continues to be part of the research spectrum. SG&T operates the Lamont Cooperative Seismic Network (LCSN), which is part of the Advanced National Seismic System, a facility supported by the U.S. Geological Survey that integrates regional earthquake monitoring into a national system. SG&T seismologists work directly with regional partners throughout the Northeast to monitor intraplate seismicity in order to assist in earthquake response and hazard mitigation. In addition, the LCSN provides fundamental data on ground motion that allows earthquake engineers to design quake-resistant structures and infrastructure.

The LCSN was operating on 9/11. The impacts of the aircraft and the subsequent collapse of the World Trade Center towers were sufficient to generate significant seismic energy in the crust, which was recorded by the seismograph on the Lamont campus. These recordings provided the most authoritative, independent measure of the disaster's chronology; forensic engineers have been using them to determine the mechanics of the impacts and the energy released during the collapse. The data were made freely available and the event times estimated by LCSN analysis were cited by President George Bush as the time of record.

2. **Seismic Record of the World Trade Center Disaster**



2. Two hours of seismographic information recorded by the Lamont Cooperative Seismic Network on the morning of Sept. 11, 2001 show the airplane impacts and the subsequent collapse of the World Trade Center's two towers. Credit: Won Young-Kim

1. Pictured are three seismic events that occurred in Manhattan in 2001: two earthquakes on Jan. 17 and Oct. 27 (black dots) and the World Trade Center (WTC) collapse on Sept. 11 (red dot). These events were recorded at the seismographic station on the Lamont campus (LAM) approximately 34 km north on the west bank of the Hudson. The dotted ellipses show areas of 95 percent certainty for the locations of the earthquake epicenters. Won Young-Kim is currently working to increase the accuracy of epicenter locations further by deploying sensors at sites throughout upper Manhattan. Credit: Won Young-Kim

More Accurate Earthquake Location Techniques

One of the most basic operations in seismology is locating earthquakes and other seismic sources. While simple in principle, in practice earthquake locations are contaminated by uncertainties arising from unknown earth structure, inadequate distribution of seismometers, and low signal-to-noise ratios. However, with clever selection of reference sources, the relative locations of earthquakes can be determined with greater accuracy. In recent years, SG&T scientists have contributed to a class of techniques that rely effectively on choosing multiple reference measurements which can, under certain circumstances, lead to more accurate maps of seismicity. By applying these new techniques to massive data sets from local and regional networks, SG&T researchers can better understand the fine-scale structure of fault systems. Division scientists are also using these techniques to more effectively monitor compliance with nuclear test ban treaties worldwide.

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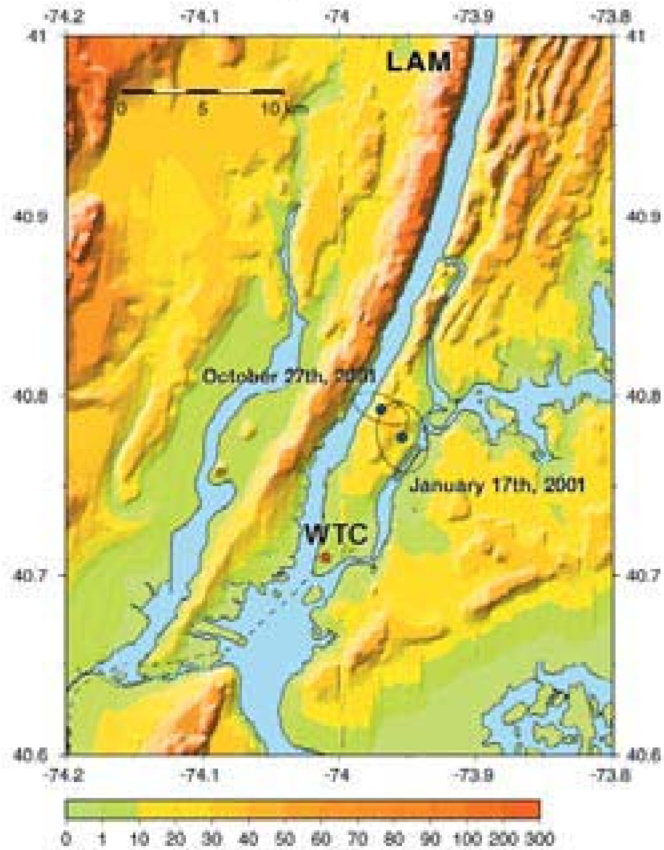

2. Observatory engineers Ted Koczynski (with umbrella) and Noel Barstow (now with the PASSCAL instrument center in New Mexico) prepare a site for the installation of a portable broadband sensor on Normanby Island off the coast of Papua, New Guinea. An array of seismometers were installed to detect the rifting of continental crust and to elucidate the structure of the crust and mantle underneath. Credit: Art Lerner-Lam

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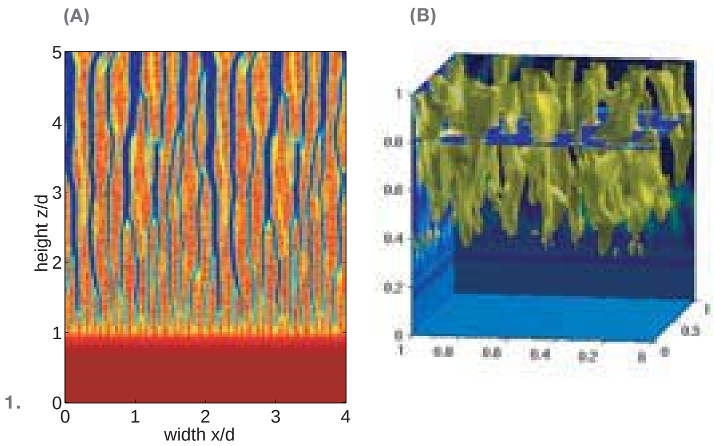
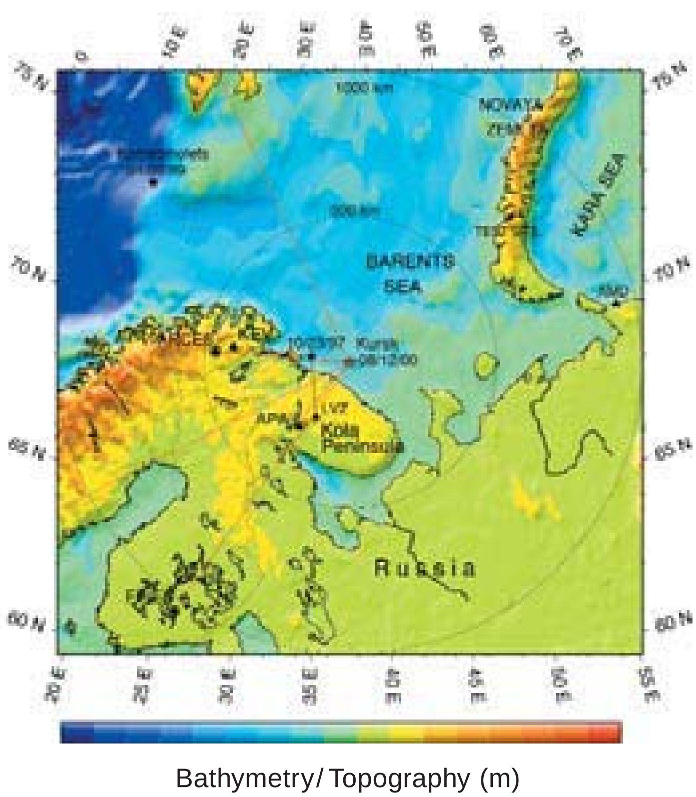


1. These illustrated calculations show that the flow of magma (molten rock) through Earth's interior can lead to the spontaneous formation of a channelized melt plumbing system—similar to the way in which surface fluid flow localizes into rivers and streams. Subsequent calculations show that these plumbing systems may have profound effects on the composition and behavior of volcanic lavas. (A) is a 2-D calculation showing the structure of the corroded channels. Channelized regions are in blue where an important mineral has been dissolved; (B) is a 3-D calculation showing the formation of tubular channels in porosity. Brighter regions have more melt in them. Credit: Marc Spiegelman

2. **Seismic Events in the Barents Sea**



New Research Centers

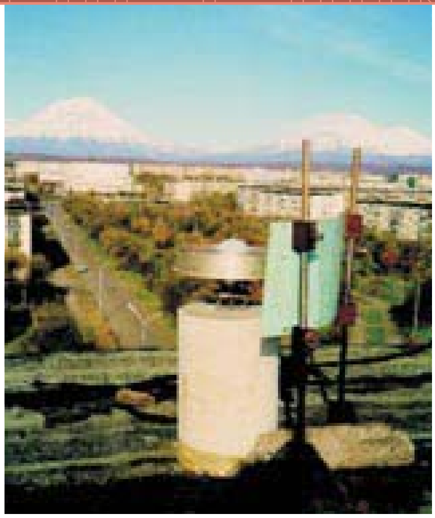
The new *Center for Nonlinear Earth Systems (CNES)* is being led by Chris Scholz. This multidisciplinary group, funded by the Observatory and The Earth Institute, combines the talents of scientists from the Applied Physics and Math program of The Fu Foundation School of Engineering and Applied Sciences and the Observatory to address fundamental problems in modeling complex Earth systems and phenomena. Differentiating the complexity of Earth processes from complexities in Earth's structure is the group's primary challenge. For example, Marc Spiegelman and his coworkers have shown that much of the variation observed in the chemical composition of mid-ocean ridge basalts may be due to their movement through the crust rather than to variations in the source magma. This understanding of mid-ocean ridge systems can be appplied to volcanic plumbing systems worldwide, improving the ability of volcanologists to predict future eruptions.

The *Center for Hazards and Risk Research* is a new multidisciplinary initiative inaugurated with seed funding from the Observatory and The Earth Institute. The Hazards Center provides coordination for the many activities around Columbia focused on natural hazards and their impacts and is developing strategies for building resiliency in human society. Examples of its multifaceted research projects follow on page 42 (Managing Risk in an Uncertain World).

Research Highlights

Using a new hyperaccurate earthquake location algorithm, Felix Waldhauser has mapped the complex interactions of the Hayward and Calaveras faults on the eastern flank of California's San Francisco Bay. The San Andreas Fault, which elsewhere in California is the main plate boundary between North America and the Pacific, branches eastward into the Calaveras and Hayward systems beneath the heavily populated

2. Sensitive seismographic stations around the world are deployed to monitor nuclear weapon tests under the Comprehensive Nuclear Test Ban Treaty. Data from these stations are also used to decipher undersea explosions, like the ones that sank the Russian submarine *Kursk* on Aug. 14, 2000, in an emerging field called forensic seismology. A known underwater chemical explosion near Murmansk on Oct. 23, 1997 (shown as a star on the map) was used for comparison. Credit: Won Young-Kim



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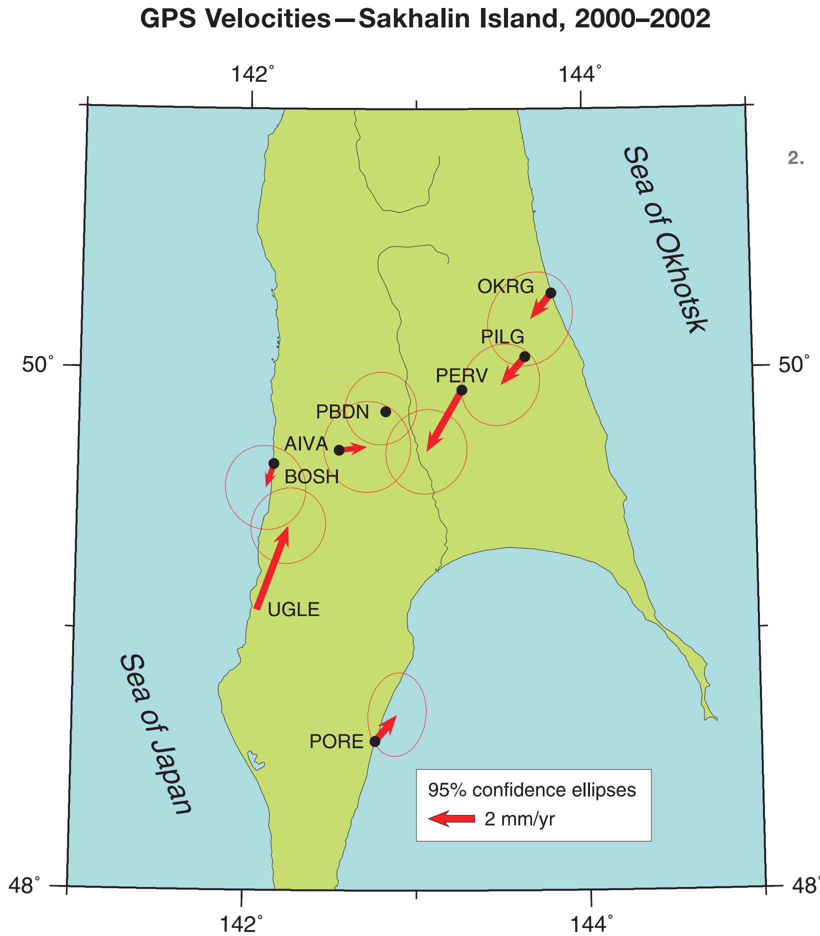

2.

1. Permanent GPS station Petropavlovsk is located in the Kamchatka region of Russia, at the boundary of the North American and Pacific lithospheric plates. The subduction of the Pacific plate is one reason for the abundant volcanism in this region. Two large volcanoes can be seen in the background: Avachinskiy (right) and Koryaksliy (left). The GPS antenna is the shiny horizontal dish set up on the white pylon (center). Credit: Mikhail Kogan

2. GPS velocities in the middle of Sakhalin Island (red arrows) clearly demonstrate the transpressional stress regime. Chris Scholz and Mikhail Kogan, who are conducting a large-scale geodetic study of the region, believe that the convergence of Eurasian and North American plates is responsible for the stress that causes frequent earthquakes along the whole length of Sakhalin Island. Credit: Mikhail Kogan

and industrialized zones of the East Bay. Waldhauser and his colleagues at the U.S. Geological Survey have been able to show that the two major systems are linked by the "Mission Trend," which has no obvious expression in the surface geology. Location algorithms yield precise images of the active substructures within and just adjacent to the fault and allow scientists to identify potential sites of future, large-magnitude earthquakes.

Mikhail Kogan and Chris Scholz have completed the first phase of their large-scale geodetic study of the cryptic plate boundary along Sakhalin Island in the Sea of Okhotsk and in eastern Siberia. This major plate boundary has resisted attempts at characterization using standard tectonic analysis and has only yielded its secrets after extensive fieldwork with highly accurate Global Positioning System (GPS) receivers. The boundary is complex, but is organized along major thrust and strike-slip features that pose a substantial threat to the burgeoning oil and gas industry in Sakhalin. In fact, Kogan was able to serendipitously record the co-seismic displacements resulting from a major earthquake in Uglegorsk, which provided the critical evidence for thrust motion that the seismic data alone were unable to resolve. This study was made possible by Kogan's continental-scale array of continuously reporting GPS receivers in Siberia and northern Russia, which provide the longest continuous baselines and some of the most accurate geodetic measurements on Earth.

Geologists Steven Pekar and Nick Christie-Blick have developed the first calibration curve for pre-Pleistocene sea level based on deep-sea oxygen isotope records. Isotope levels in deep-sea sediments depend on both ocean water temperatures and ice volumes at the poles. They were able to remove the effect of ice volume from the isotopic record in order to measure the variability of deep water temperature alone. Their results suggest that Southern ocean deep water temperature variations between glacial and interglacial periods at million-year time scales were smaller than those in tropical surface water or in mid- and low-latitude deep water. These findings support the hypothesis that moisture transport to the poles may have been a more important factor than previously thought in the initiation of large Antarctic ice sheets at the beginning of the Oligocene period and may lead to further understanding of current climate variability.

1.

Dennis Hayes, Professor of Earth and Environmental Sciences
Associate Director, Office of Marine Affairs

Over the past two years the R/V *Maurice Ewing*, the Observatory's signature research ship, has circumnavigated the globe while continuing its role as a national facility for collection of marine seismic data using Multichannel Seismic (MCS) reflection techniques. The *Ewing* is the only ship in the University–National Oceanographic Laboratory System that has MCS capabilities.

No fewer than 11 of the 17 expeditions over the past two years included a seismic component. Although research aboard the *Ewing* is conducted by scientists from many institutions, 3 expeditions in the past two years were led by principal investigators from the Observatory.

One of these focused on the contrast in continental rifting styles between northwest Australia's Exmouth Plateau and the area immediately to the south. Observatory scientist and Coprincipal Investigator Garry Karner supervised multichannel seismic profiling of the area and the acquisition of Ocean Bottom Hydrophone (OBH) refraction data. Other participating institutions included the Hawaii Institute for Geophysics, the U.S. Geological Survey and the Scripps Institute of Oceanography. Cruise dates for this expedition, which started and ended in Fremantle, Australia, were October 27 through December 2, 2001.

In December 2001 and January 2002, Observatory scientists Jim Cochran and Jackie Floyd led a multifaceted investigation of the southeast Indian Ridge, located in stormy seas between southeastern Australia, Kerguelen and the Antarctic. During this expedition MCS and OBH data were acquired. Multibeam (swath) bathymetric sonar was also used to gather data. Long transit times to the work area, located at 50 degrees south latitude, made for a long cruise.

Observatory scientist Suzanne Carbotte led a detailed survey of the Juan de Fuca Ridge off the coast of Washington State and Vancouver, Canada, in the summer of 2002. Although much was known about shallow hydrothermal activity on and around this medium-spreading-rate oceanic ridge, the correlation between this activity and deeper structures was previ-

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2. Observatory Director G. Michael Purdy (center) addresses representatives of the Greek Press in Athens, Aug. 2001, in front of R/V *Ewing*, with its whimsically decorated marine seismic container.

1.

ously unknown. On this expedition, deeply penetrating MCS surveys for the first time provided images of the ridge-feeding magma chambers, the interesting porous shallow layer feeding the hydrothermal fields and the surrounding Moho, which forms the base of the oceanic crust.

Another four legs of the *Ewing's* journey accomplished tasks related to physical oceanography and biology. Many of the seismic legs also included the taking of samples and measurements for other marine geological disciplines, including heat flow, coring and swath bathymetry.

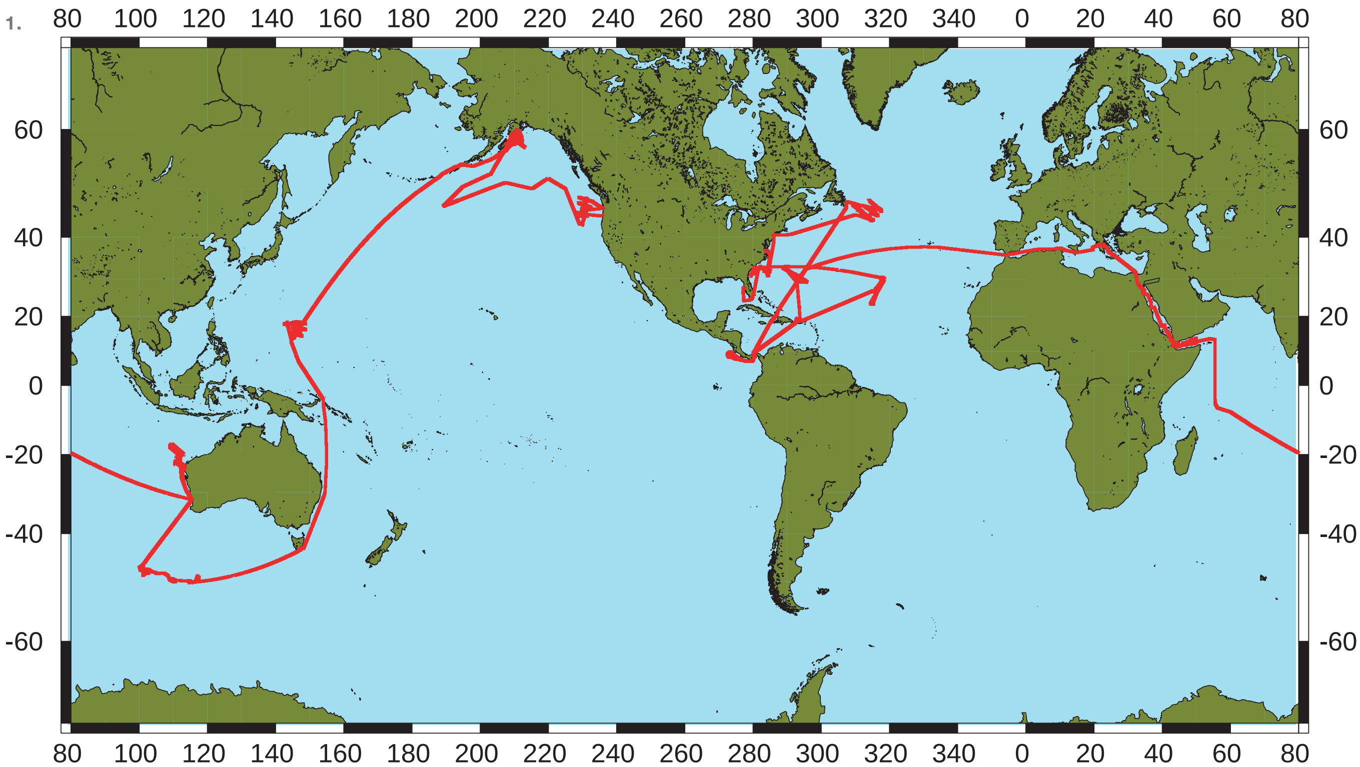
Research expeditions during the last two years continue a longstanding tradition of discovery and innovation aboard Observatory vessels. MCS work aboard Observatory ships began in 1974 on the R/V *Conrad*, which was outfitted with a seismic source of four air guns and a 24-channel, 2,400 m long hydrophone array.

1. Technicians and crew of the Juan de Fuca MCS survey, during night operations, launch a hydrophone array's tail buoy, which communicates its position 6.2 km behind the R/V *Ewing*.

2. R/V *Ewing* collecting MCS data in the Gulf of Corinth, Greece, July 2001. The ship's 20 air guns are towed from two booms on the fantail.

2.

1.

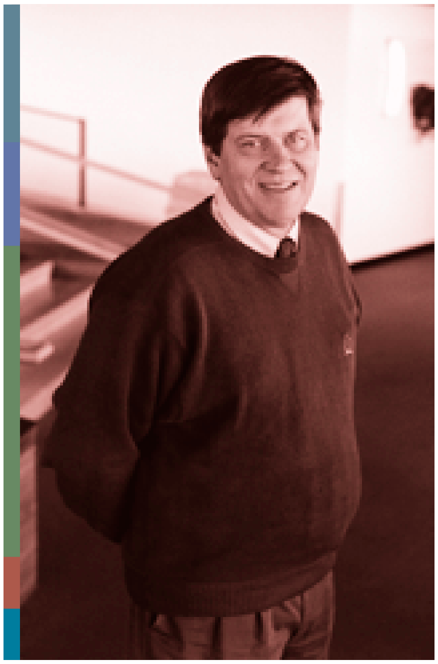


1. The global course followed by the R/V *Ewing* between July 2000 and July 2002.

The *Ewing's* original conversion in 1990 included the addition of a 20–air gun seismic source array, and its most recent upgrade, funded by the National Science Foundation in 1998—which included installation of a 480-channel, 6 km long hydrophone array and acquisition system—makes the *Ewing* the only ship in the U.S. academic fleet capable of performing MCS surveys around the world.

The *Ewing* is named after Maurice Ewing, the Observatory's founder and first director, under whose leadership the Observatory became the first institution in the world to routinely collect precision depth recordings of the seafloor, seismic reflections of the layers below the seafloor, gravity and magnetic measurements and probes of the heat flow through the seafloor, as well as seafloor sediment cores and ocean bottom photographs.

2.



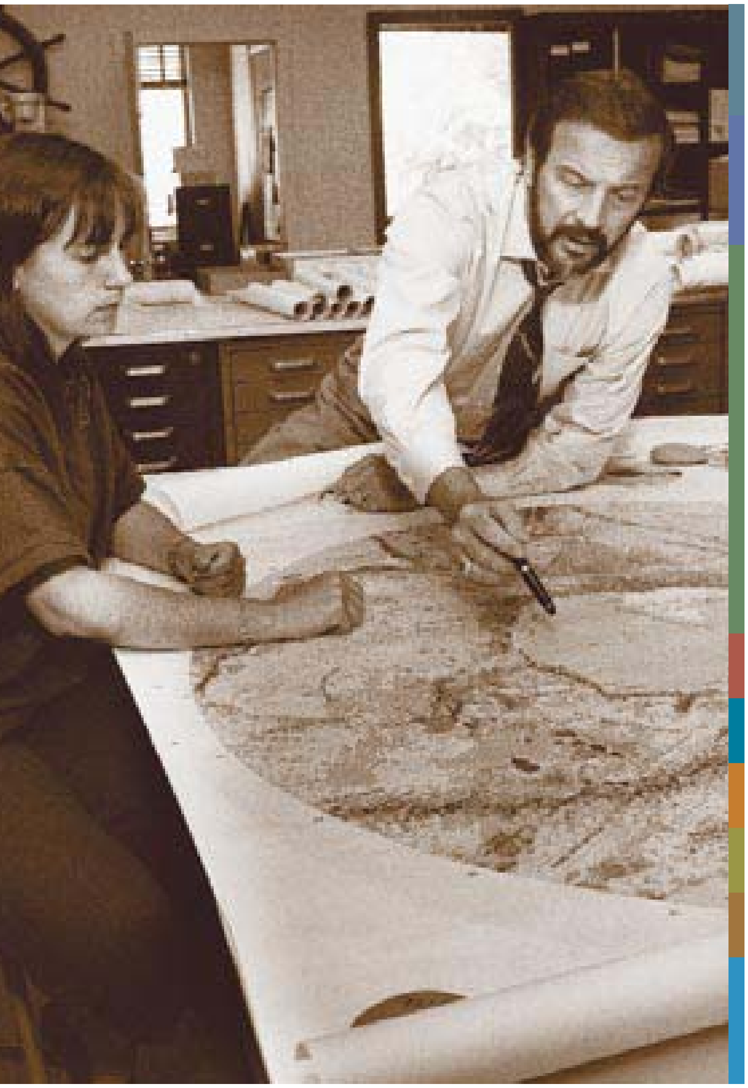
3.

2. Paul Ljunggren, Senior Staff Associate
Marine Superintendent
3. John B. Diebold, Research Scientist
Marine Science Coordinator

Schedule for the R/V *Ewing*: July 2000 – July 2002

CRUISE DATES	PRINCIPAL INVESTIGATOR INSTITUTION	PORTS
2000		
JULY 1 to JULY 11	TRANSIT	Colon, Panama St. John's, NF, Canada
JULY 15 to AUGUST 16	Brian Tulcholke Woods Hole Oceanographic Institution	St. John's, NF, Canada Newark, NJ
SEPTEMBER 2 to OCTOBER 17	Steve Holbrook University of Wyoming	Newark, NJ Norfolk, VA
2001		
FEBRUARY 9 to FEBRUARY 21	Margarita Trujillo United States Navy	Tampa, FL Charleston, SC
MARCH 11 to APRIL 5	Brian Tucholke Woods Hole Oceanographic Institution	Charleston, SC San Juan, PR
APRIL 8 to APRIL 12	TRANSIT	San Juan, PR Colon, Panama
APRIL 14 to MAY 19	Andrew Fisher University of California, Santa Cruz	Colon, Panama Colon, Panama
MAY 23 to MAY 29	TRANSIT/HYDROSWEEP UPGRADE	Colon, Panama San Juan, PR
MAY 31 to JUNE 30	James Gaherty Georgia Institute of Technology	San Juan, PR Bermuda
JULY 3 to JULY 21	TRANSIT	Bermuda Patrai, Greece
JULY 23 to AUGUST 1	Brian Taylor School of Oceanographic and Earth Science Technology, University of Hawaii	Patrai, Greece Piraeus, Greece
AUGUST 4 to AUGUST 11	TRANSIT	Piraeus, Greece At sea
AUGUST 12 to AUGUST 18	William Johns Rosenstiel School of Marine and Atmospheric Science, University of Miami	At sea Djibouti, Eritrea, Egypt, Yemen, Djibouti
AUGUST 21 to SEPTEMBER 12	William Johns Rosenstiel School of Marine and Atmospheric Science, University of Miami	Djibouti, Eritrea, Yemen, Djibouti
SEPTEMBER 13 to SEPTEMBER 20	TRANSIT	Djibouti Seychelles
SEPTEMBER 24 to OCTOBER 4	IN PORT	Seychelles Seychelles
OCTOBER 6 to OCTOBER 19	TRANSIT	Seychelles At sea
OCTOBER 20 to OCTOBER 23	Donna Blackman Scripps Institution of Oceanography	At sea Fremantle, Australia
OCTOBER 27 to DECEMBER 2	Neil Driscoll Scripps Institution of Oceanography Garry Karner Lamont-Doherty Earth Observatory	Fremantle, Australia Fremantle, Australia
DECEMBER 7 to JANUARY 26	James Cochran Lamont-Doherty Earth Observatory	Fremantle, Australia Hobart, Australia
2002		
JANUARY 31 to FEBRUARY 15	TRANSIT	Hobart, Australia Agana, Guam
FEBRUARY 16 to FEBRUARY 21	IN PORT	Agana, Guam Agana, Guam
FEBRUARY 24 to MARCH 26	Brian Taylor School of Oceanographic and Earth Science Technology, University of Hawaii	Agana, Guam Agana, Guam
APRIL 1 to APRIL 26	Brian Taylor School of Oceanographic and Earth Science Technology, University of Hawaii	Agana, Guam Agana, Guam
APRIL 27 to MAY 8	TRANSIT	Agana, Guam Dutch Harbor, AK
MAY 12 to JUNE 10	Phyllis Stabeno Pacific Marine and Environmental Lab/NOAA	Dutch Harbor, AK Kodiak, AK
JUNE 14 to JULY 3	Marie Eble Pacific Marine and Environmental Lab/NOAA	Kodiak, AK Astoria, OR
JULY 8 to AUGUST 7	Suzanne Carbotte Lamont-Doherty Earth Observatory	Astoria, OR Newport, OR

Educating a New Generation of Earth Scientists


1.

Professor and Department Chair Dennis Hayes reviews the intricacies of a topographical map of the ocean floor with graduate student Karen Ricciardi.

Located primarily on the Lamont campus in Palisades, New York, the Department of Earth and Environmental Sciences (DEES) occupies a unique position as the lead academic department for the research endeavors of the Observatory. This powerful partnership brings together a remarkably large and comprehensive collection of personnel and facilities and makes them readily available to both undergraduate and graduate students.

Through the Department, students at both the undergraduate and graduate levels develop the tools of analysis and intellectual staying power they need to investigate complex, socially relevant, interdisciplinary problems—problems that will necessarily draw on all aspects of the Earth sciences for their solutions. Studies range from Earth's origin and history to the processes taking place within oceans and across continents.

In addition to the Department's 40 regular and adjunct faculty members, another 70 Ph.D.-level research scientists at the Observatory play critical roles in advising and supporting students, as well as in directing student research projects. The ratio of Ph.D. students to Ph.D. scientists is roughly one-to-one. These collective human resources define the intellectual firepower that makes our education and research programs so outstanding. Students are recognized as vital contributors to the continuing intellectual renewal and discovery process that define the Department, as well as the Observatory itself.

The level of excitement that the Department's Ph.D. students generate is extraordinary. Not only do they bring back measurements and samples—and Friday afternoon tales—from far-flung field sites, such as the

2.


2. Graduate student Michael West, now a post-doc at New Mexico State, stands with Professor Bill Menke in Godofos, Iceland where he gained seismic experience imaging subterranean magma shifts.
3. Elizabeth Cottrell is a graduate student who works in one of the Observatory's experimental labs studying planetary differentiation. Here, she is seen at the summit in Torres del Paine National Park in Patagonia after spending over two months at sea as a member of a research expedition jointly organized by the Observatory and Brown University. Credit: David Stevenson

3.

volcanoes of Mexico and the depths of the Southern Ocean, they break new ground developing analytic techniques and keep the Observatory's mass spectrometers, seismometers and computers humming.

The Department also has strong ties with other major research institutions, such as the American Museum of Natural History, and with NASA's Goddard Institute for Space Studies at Columbia, and collaborates with many other departments within Columbia in both research and educational arenas. Two recently developed programs include:

1. The Earth and Environmental Science Journalism Program: a collaborative effort between the Department and Columbia's Graduate School of Journalism whose goal is to produce graduates with a rare blend of scientific knowledge and journalistic skills.

2. A new joint educational program in Mathematical Geosciences: a collaborative effort between the Department and Columbia's Department of Applied Physics and Applied Mathematics (see Seismology, Geology and Tectonophysics, page 24) that has recently been awarded a major National Science Foundation grant, the Innovative Graduate Education and Research Training Award. This new program will educate graduate students in advanced mathematical methods that can be applied to a wide range of problems in the geosciences.

Looking forward, the real challenge for the Department of Earth and Environmental Sciences lies in cultivating in students a heightened awareness of how research can positively affect global sustainability, mitigate threats of global warming and the loss of biodiversity, and alleviate human suffering.

4.

3. Elizabeth Cottrell is a graduate student who works in one of the Observatory's experimental labs studying planetary differentiation. Here, she is seen at the summit in Torres del Paine National Park in Patagonia after spending over two months at sea as a member of a research expedition jointly organized by the Observatory and Brown University. Credit: David Stevenson
4. Director Michael Purdy is joined by several members of the DEES faculty at one of the Department's bimonthly faculty meetings. Clockwise from left to right: Marc Spiegelman, Mike Purdy, Bill Ryan, Stephanie Pfirman, Jim Hays, John Mutter, Dave Walker, Peter Schlosser and Bob Anderson. Credit: Mark Inglis
5. Here a student uses a hand lens to compare fossils and climate conditions on a field trip. Credit: Department of Earth and Environmental Sciences

5.

Earth & Environmental Science Journalism Program

The Lamont campus is fertile ground for pioneering research into the most complex interrelations of Earth and its environment. Beyond engineering state-of-the-art laboratories and groundbreaking discoveries, Observatory scientists are increasingly involved in bringing scientific understanding to constructive dialogue about the future of Earth.

A number of successful programs enable Observatory scientists to interact with business and political leaders, educators, citizens and students who are not necessarily scientists. Leaders and citizens who have greater awareness of Earth's natural systems and environmental processes are likely to make better informed decisions and to support a more environmentally sound agenda. Conversely, investigators who understand the public's concerns, priorities and fears are more likely to consider those issues when deciding which questions to tackle and when articulating the implications of their findings.

Working with journalists, professional societies, community groups, teachers and museums, Observatory researchers have sought new strategies to make their findings more accessible and available to the public.

Columbia's Earth & Environmental Science Journalism (E&ESJ) Program is a dual master's degree program, cosponsored by the Observatory, the Department of Earth & Environmental Sciences, and Columbia's Graduate School of Journalism. The program trains graduates to report and write about discoveries, insights and controversies concerning Earth and environment in a way that is both accurate and interesting. The program graduated its fifth class in 2002. Collectively, E&ESJ graduates published some 300 articles last year, reaching hundreds of thousands of readers, in such media as the Albany *Times Union, The New York Times, Discover, SciAm.com, Scientific American, Geotimes, The Wall Street Journal, The News-Record* (Gillette, Wyoming), *BioMedNet*, and *Newsday*. The program graduated its first international students—from Canada and Japan—this year, and graduate Dina Cappiello received the Associated Press's New York State Young Journalist of the Year Award.

1.

1. Graduates of the Earth and Environmental Science Journalism Program have gone on to cover science and environment topics in publications across the country. Credit: Linda Pistolesi

Increasing Diversity In and Through Environmental Journalism

The Columbia Earth & Environmental Science Journalism Program, the Society of Environmental Journalists (SEJ), the Native American Journalists Association (NAJA), the National Association of Black Journalists (NABJ), and the National Association of Hispanic Journalists (NAHJ) have begun a three-year collaboration on diversity in environmental journalism. The immediate goal is to increase the quality, visibility and accuracy of environmental coverage in media reaching Native American, black and Hispanic audiences, as well as the coverage of environmental issues of concern to minority communities in the mainstream press. A broader goal is to plant seeds of interest in Earth and environment among populations seriously underrepresented in the Earth sciences. Funded by the National Science Foundation, the project provides trial memberships in SEJ and fellowships to attend SEJ meetings to journalists of color, and sponsors jointly organized panels, workshops and field trips on environmental issues.

Dina Cappiello, a graduate of the Earth and Environmental Science Journalism Program, reported extensively on PCBs in the Hudson River for the Albany *Times Union*. Her in-depth coverage won her several major journalism awards. Credit: Paul Buckowski, Albany *Times Union*.

Opening Minds

Having put tremendous thought and planning into her future as a science teacher, Dina Cappiello paused on her first day of class at Columbia's Teachers College to peruse a Columbia course booklet and chanced upon the Earth and Environmental Science Journalism program. "I had never thought of science writing as a career—my neurons just weren't firing that way," she says.

Exactly two years from her career epiphany, Dina emerged as one of the first graduates from this intensive new dual master's degree program. Dina's first job was with the Albany *Times Union*. Within an impressively short time, her articles, with front-page headlines like "Lakes Are Dying, Drop by Drop," "Counting the Forests' Senior Citizens" and "Changing by Degrees," were providing scientifically informed journalism on acid rain, old-growth trees and climate change. Inspired by plans for dredging and concerns over PCBs, Dina produced a series of articles on the Hudson River that landed her the Associated Press's New York State Young Journalist of the Year Award in 2001. That year, she also took first place in their category for best in-depth reporting and second place for best continuing coverage. In 2001, Dina's "Showdown on the Hudson" series made her a finalist for the Livingston Award for Young Journalists—the nation's largest all-media, general reporting prize, and a major achievement for a journalist just out of school.

Only three years into a very bright career as an environmental reporter, Dina has moved to a larger market, now writing for the more than half a million readers of *The Houston Chronicle*. "I want to delve into the deeper issues of science and educate people, not just present a sensationalistic approach," remarks Dina. "I wouldn't be able to do this without the solid foundation in science education that I received in the Earth and Environmental Science Journalism Program." Her long-term goals? "To be an environmental writer forever, and by the way, I'm also the teacher I started out to be."

Enhancing Public Understanding of Earth and the Environment

Hudson River Project

Working with local high school advanced placement biology, chemistry and research science classes, the Observatory conducts a water-monitoring program at the Piermont Pier. Students compare the chemical, physical and biological environment of the Hudson River during a fall and spring visit. Students take part in hands-on chemical testing and a physical inventory of the site, and end with a discussion of the processes that they have witnessed and the interdependent relationships of these processes. Graduate students volunteer to assist these students and provide short talks on their own research.

In their role as the Hudson Basin River Watch local coordinator, Observatory researchers coordinate several programs that train interested residents and volunteer groups in stream monitoring techniques and provide direction, support and report-writing expertise for environmental groups in Rockland County. The Observatory, in collaboration with Westchester County and Save the Sound, also hosts an annual land use symposium designed to educate middle school students on the impacts that local development and land use decisions have on the environment, especially highly sensitive estuary areas.

Digital Library for Earth System Education (DLESE)

The Digital Library for Earth System Education (DLESE) is a nationwide effort to improve Earth and environmental education by gathering, cataloguing, reviewing and disseminating excellent resources for teaching and learning about Earth, and by providing the support that enables educators to use these resources effectively. DLESE is part of a broader effort, the National STEM Education Digital Library, which spans education in all of the sciences, engineering, math and technology.

Observatory scientists occupy key roles in the DLESE leadership: Jim Hays is part of the Steering Committee and Kim Kastens chairs the Collections Standing Committee. In addition, the DLESE Community Review System is being developed at the Lamont campus. This innovative effort will identify the best educational resources in the DLESE Broad Collection to be included in a high-quality Reviewed Collection. The Reviewed Collection is being developed through community feedback via a web-mediated recommendation engine and specialist reviews mediated through an Editorial Review Board.

Earth2Class Workshops for Teachers

Earth2Class workshops for teachers provide monthly programs that bring together Observatory research scientists and classroom educators. Each three-hour Saturday session includes background information on a theme, descriptions of cutting-edge research by the scientist(s) and discussion of classroom investigations and/or educational technology applications. Themes range from natural hazards, climate change and marine geology to water resources and imaging our planet. Michael J. Passow, adjunct professor of Science Education at Teachers College, and Cristiana Assumpcao and Frederico Baggio of the E2C team also provide these programs, through teleconferencing technologies, to teachers at remote locations. Graduate education credit for participation in E2C is available through the Teachers College Center for Educational Outreach and Innovation and through St. Thomas Aquinas College.

1. Rica Enriquez, an environmental engineering intern, taking temperature, salinity, and depth profiles of the Hudson River. Credit: Peter Schlosser

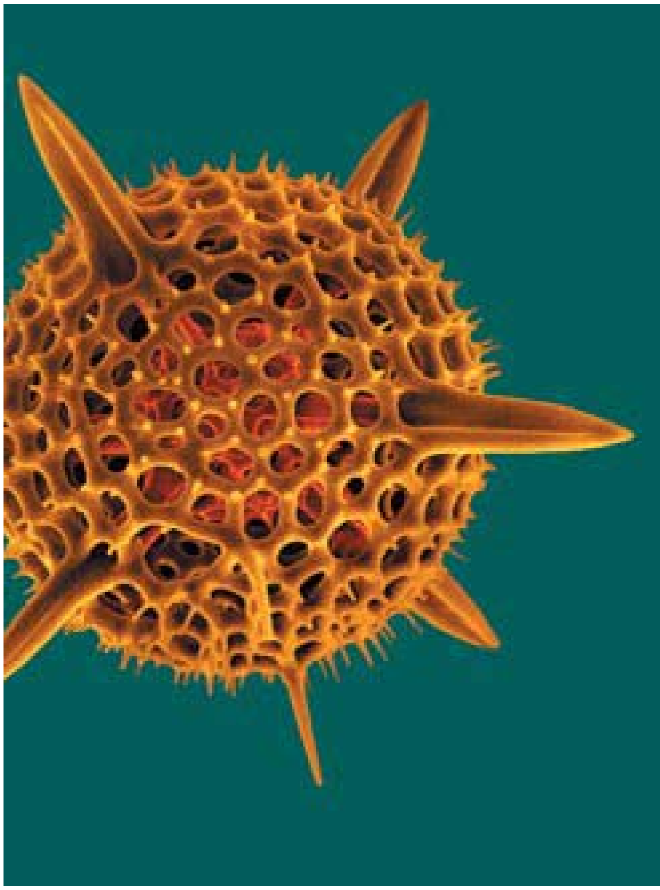
1.

Scanning Electron Microscopy Exhibits

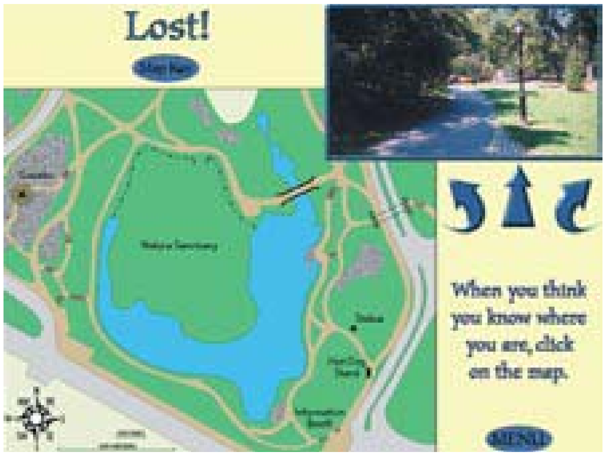
Dee Breger is the author of two widely acclaimed books revealing the beauty, patterns and intricacy of nature on the microscopic scale: *Journeys in Microspace: The Art of the Scanning Electron Microscope*, Columbia University Press, 1995; and *Through the Electronic Looking Glass: 3-D Images from a Scanning Electron Microscope*, Cygnus Graphic, 1995. She designed the permanent SEM exhibit at the Liberty Science Center in New Jersey. Images from Breger's collection have been featured in exhibitions at Liberty Science Center, Rochester Institute of Technology, Ceske Budejovice (Czech Republic), the Victoria and Albert Museum (London), Martin Gropius Bau (Berlin), Manhattan Children's Museum and Petrosains Science Center (Kuala Lumpur) and have been widely reproduced in the media and in several books on scientific imagery.

"Where Are We?" and Map Skills Project

The ability to use maps and other spatial representations is essential in the geosciences and important in everyday life for an increasingly mobile population. In collaboration with colleagues at Columbia's Teachers College, Kim Kastens has produced and published an educational software application and associated instructional materials entitled "Where Are We?" The materials help elementary school children learn to make the mental translation between what they see on a map and what they see in the terrain around them. Development of the software has led to a broader geoscience-education research project on children's acquisition of map skills, and children's and teachers' misconceptions about maps. The Lamont campus itself has been turned into a research instrument, as Kastens and colleagues bring groups of students to campus and engage them in field-based map skills tasks.



1. Dee Breger, Manager of the SEM/EDX facility and a micrographic artist, magnified a fossil radiolarian from the Ross Sea off Antarctica 500 times. Radiolaria are single-celled free-floating protozoa found in all the world's oceans. Credit: © Dee Breger



2. Students using the "Where Are We?" software and associated curriculum learn how to recognize landmarks and spatial relationships, plan and follow routes, provide directions to others, use compass directions, recognize symbols and analyze a complex visual environment. Credit: Kim Kastens

3. Kim Kastens and Toru Ishikawa are researching students' acquisition of spatial skills and the use of spatial thinking in the geosciences. Here, local elementary school students are engaged in a field-based map skills activity on the Lamont campus designed to test their ability to transfer information from the real world onto a map. Credit: Kevin Warner

1.

1. The Observatory has held a Summer Intern Exchange Program for undergraduate students for 25 years. Over 200 interns from colleges and universities across the country have participated in the program, many of them going on to careers in the sciences. Pictured are the interns from the summer 2001 program. Credit: Department of Earth and Environmental Sciences

Opening the World of Research to Undergraduates

Sometimes, seeing is believing. For the past 25 years, the Lamont-Doherty Earth Observatory, in collaboration with Columbia's Department of Earth and Environmental Sciences, has hosted the Summer Intern Exchange Program, which aims to stimulate undergraduates from around the country to pursue ocean and Earth science research. In the summer following their junior year, promising students majoring in oceanography, geology, physics, chemistry, math, biology, environmental science or engineering are given the opportunity to work alongside senior scientists on one of the Observatory's many exciting research projects.

Over nine weeks, students gain firsthand exposure to a specific research project, as well as a broader introduction—through a twice-weekly lecture series—to the wide range of oceanographic and geological research undertaken at the Observatory. Invited lecturers are not only senior, nationally recognized researchers, but also younger scientists and senior graduate students whom undergraduates view as mentors and role models.

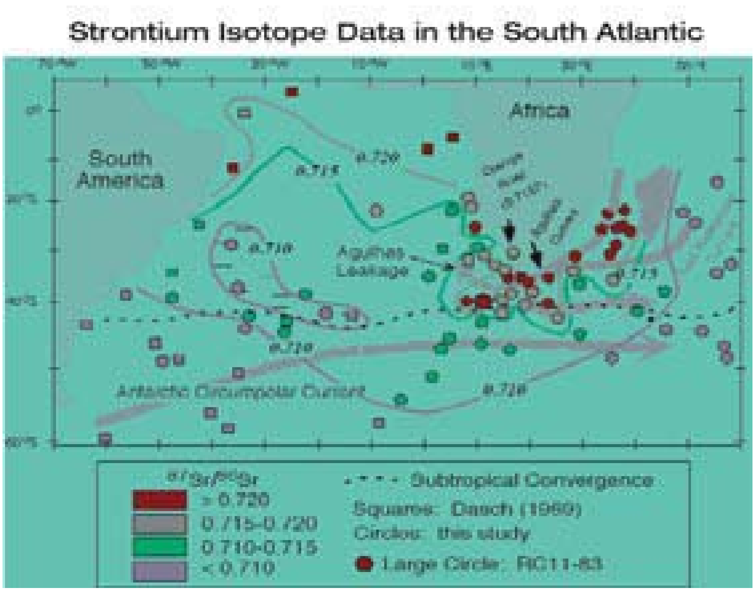
To facilitate student-researcher interaction and to maximize the research experience, students receive one-on-one supervision, meeting daily with research advisers and weekly with the program coordinator.

In the seventh week of the program, several senior scientists host a panel discussion on ethics, highly rated by the students. Having had a chance to experience life as research scientists, students next attend a panel discussion with selected senior researchers to discuss careers in science. These discussions also cover related areas of study, sources of employment and graduate school programs, including non-research-oriented career tracks.

The intern program ends with a written summary and oral presentation. These oral presentations are a very important part of the program and are attended by many members of the Lamont community.

Some interns continue their summer projects as senior theses, especially those from schools that give academic credit for work on a senior thesis. In some cases, projects lead to coauthorship on published papers, with the number of student coauthored papers and abstracts continuing to increase.

More than 200 students have taken part in the program since its inception; last year, a total of 14 young scientists completed the program. About 40 percent of our interns go on to become teachers at the high school or college level, while about 20 percent go on to obtain Ph.D. degrees.

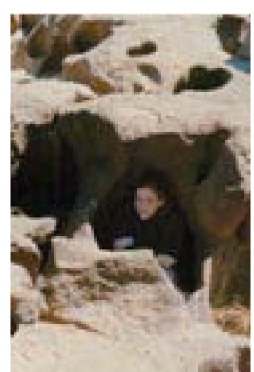


2.

2. As part of her research, summer intern Stacey Kepler characterized the strontium isotope composition of sediments along the South American coast. By studying the natural variation of these isotopes and their arrangement where surface ocean currents converge, scientists can explain past changes in surface ocean circulation. Credit: LDEO archives

3. Summer intern Sarah Brownlee is a geosicience major at Princeton University. Here, she examines geolocial events during a field trip in California. Credit: Sara Carena

3.



Sarah Brownlee has made nearly 500 jumps from airplanes. Over the course of the 2002 Summer Intern Exchange Program, she convinced several of her fellow interns to join her for a 13,500 foot plunge. Credit: Dave Pancake

Hands On

A senior in geosciences at Princeton University, Sarah Brownlee leaped at the opportunity to spend the summer of 2002 at the Lamont-Doherty Earth Observatory. Sarah and 13 other undergraduates from schools around the country descended upon the campus as members of the Summer Intern Exchange Program, eager to work beside the Observatory's esteemed scientific staff. "I wanted to know what it is like to do actual research, not just to read about it in the geosciences textbooks I had been pouring over for the last few years," she says.

With nine research areas to choose from, Sarah zeroed in on sedimentology, marine geology and marine micropaleontology, and spent the summer under the guidance of Drs. Cecilia Gonzalez McHugh and Lloyd Burckle. She studied sediment cores taken from the bottom of the Hudson River, using the presence of tiny single-celled plants called diatoms and the physical structure of the sediments to demonstrate how the Hudson Estuary reacts to tidal processes. From six cores, Sarah counted diatoms and prepared them for microscopy.

"What I like about Lamont's intern program is that some of the interns don't disappear at the end of summer," comments Burckle. "Sarah has turned her summer internship into her senior year thesis at Princeton University. She still comes to the lab once or twice a week."

"The internship was an awesome experience," says Sarah. "Graduate school is in the future, but first I want to travel a bit and do a little sky diving. On a hot day at 13,500 feet, you can see the pollution over Philadelphia. It has me thinking about the atmosphere—perhaps something I'll study."

Rivers and Estuaries Research on the Hudson

The quantity, quality and security of Earth's fresh water supply, much of which rests in the world's rivers, is an ongoing and critical concern. Because many of the world's major cities lie along the banks of rivers and estuaries, these enormous tracts of water become extraordinarily vulnerable to the effects of pollution, shifts in ecology and innumerable other anthropogenic perils.

Researchers at the Lamont-Doherty Earth Observatory have formed a Hudson River Research team to develop a systems approach to understanding the Hudson River and Estuary, the watershed that runs from the Adirondack Mountains of upstate New York through New York Harbor out to the shores of Long Island.

By studying the Hudson on multiple levels and scales, from its surface to its depths, from its mud to its marshes, these scientists hope to shed light on the complex relationships humans have to the rivers they live near and use for recreation, transportation and commerce and as drinking water supply sources.

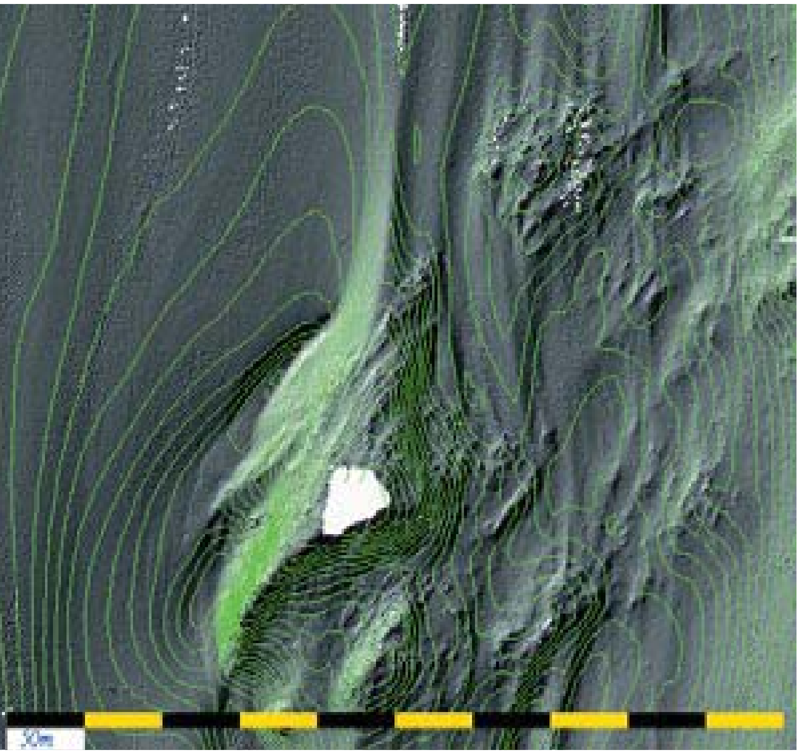
In recent years, the Observatory has become a major contributor in New York State to the study of the Hudson River and its dynamic environs, where remnants of a glacial past, invasive zebra mussels, underwater dunes reminiscent of the Sahara Desert, and the presence of toxic waste come together.

1.

Mapping the Hudson

Robin Bell and her colleagues have meticulously accounted for every curve, crevice, ridge and valley of over 90 miles of the river floor, from the Verrazano Bridge to the Federal Dam at Troy, including New York Harbor. Their map reveals a dynamic riverbed, with large dunes of sand and gravel, banks of oysters, archaeological artifacts and great swaths of the river that have been physically altered by centuries of human activity. This map has also identified places where recent mud has settled, since contaminants like PCBs tend to be found in recent mud.

In the spring of 2002, Michael Studinger and Frank Nitsche conducted the first systematic measurements of the magnetic field from just south of the Tappan Zee Bridge to 59th Street in Manhattan. The dramatic bends and folds in the map are produced by the bedrock in Westchester County driving beneath the river to depths of several hundred feet. Atop this natural backdrop, the map reflects the history of human use of the river, such as the crisscrossing of natural gas pipelines that power the lights of New York and New England, and long-collapsed piers.



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1. Robin Bell talking with *New York Times* columnist Bob Boyle, aboard the R/V *Walford*. Boyle reported on Bell's bathymetric mapping of the Hudson River bottom. Credit: Richard Perry
2. An illuminated bathymetry map of Diamond Reef, an underwater marble cliff in the Hudson River. Credit: Roger Flood, Marine Sciences Research Center, Stony Brook, State University of New York

1.

1. Map of a section of the Hudson River created with a Geographic Information System program using U.S. Geological Survey data. Credit: Frank Nitsche.
2. A navigational chart showing the Piermont section of the Hudson River and Piermont Pier, the site of the Riverscope node used to capture the river's rhythms in real time. Credit: National Oceanic and Atmospheric Administration (NOAA)

Understanding the Hudson and Its Surroundings

Arnold Gordon is leading a team of researchers in a comprehensive study of the physical, chemical, geological and biological systems within Jamaica Bay—a complex salt marsh environment that is seriously threatened by its urban surroundings. Members of the team have already defined sediment terrains and characteristics of marsh loss and identified a number of island salt marshes that may be eroding or drowning. Some researchers have amassed temperature, salinity and water current records, documenting the changing nature of the bay, while others have calculated a flushing time for contaminants that may be introduced into the region. The team has also focused on providing critical information on nutrient levels and the bay's biogeochemical responses to human activity while exploring the effects of urban development on the bay's wildlife habitats.

How Contaminants Move through the Hudson

In a recent series of experiments, a team of researchers, led by Peter Schlosser, David Ho and Ted Caplow, injected trace amounts of a harmless, inert gas into the Hudson River to see how quickly it would spread through the water. During one such experiment in the summer of 2001, scientists were surprised to find that the highest concentration of gas did not move significantly from Newburgh, where it was first injected into the river, but that various amounts of the gas had spread throughout a large stretch of the river. This experiment has shown that the decrease in the concentration of the gas was caused not by the flow of the river but instead by the mixing of the river, which is linked to tidal motion. This result has tremendous implications for understanding the way in which contaminants move through the river and how best to follow them for cleaning.

These tracer field studies are augmented by numerical simulations of the spreading of perturbations in the Hudson River. The goal of these modeling studies is to put the measurements into a dynamic framework and to help with the interpretation of the evolution of the tracer distributions over time. First results are promising and suggest that the tidal forcing of the circulation in the Hudson River has significant impact on primary and secondary features of the observed tracer distributions. The modeling work is being performed in collaboration with the Department of Earth and Environmental Engineering and the Earth Engineering Center.

In a related study, Robert Houghton and colleagues have shown that the modulation of the mixing in the stratified lower Hudson by the spring/neap tidal varia-

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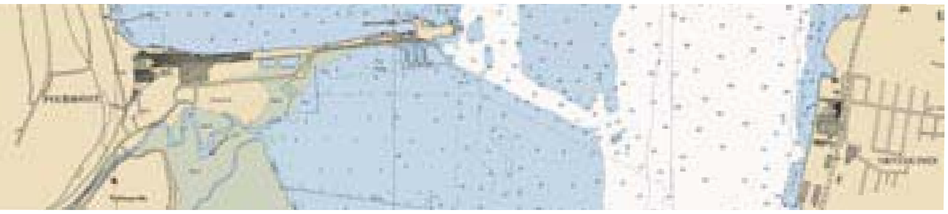

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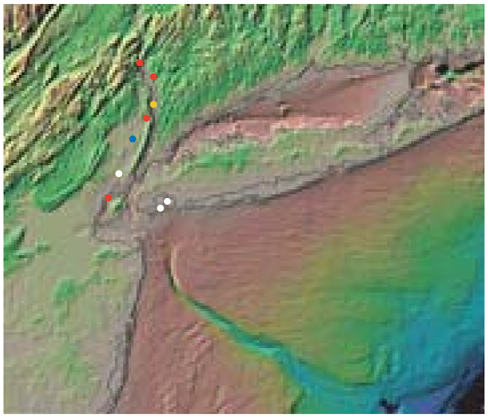

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1. Observatory scientist Cecilia McHugh with two interns conducting gravity cores in the Hudson Highlands. They were collecting sediments to capture clues of ancient storms and the accumulation of contaminants in the riverbed. Credit: Robin Bell
2. A regional map of the lower Hudson Estuary marking locations where wetland cores were taken. Fossils found in the sediments are used by scientists to reconstruct historic climates and environments. Credit: Dorothy Peteet

tion is significantly greater than had originally been believed. As a consequence, the net up-river flow near the bottom is greater during neap (weak) tides and nearly absent during spring (strong) tides. Using a harmless dye tracer, scientists were able to measure the tidally driven flow in the Hudson River, including the weak but significant cross-channel (east/west) flow. Within hours, the tracer, injected near the bottom of the deepest portion of the river, the navigation channel on the east side, just north of Spuyten Duyvil, had moved across the river channel to shallow water on the west side. Their research suggests that this rapid movement contributes significantly to the mixing of pollutants introduced into the water.

The Environmental Geochemistry Group, a group of Observatory scientists led by James Simpson, has been analyzing components of Hudson geochemistry since the early 1970s. These researchers continue to study the impact on nutrient species distributions within the estuary as a result of very large discharges of sewage and other waste into the New York/New Jersey harbor complex. They have also measured dissolved gases to improve our understanding of how contaminants are influenced by microbial processes in river sediments and the water column. Over the years, Steve Chillrud and others have collected a large number of sediment cores from the Hudson River basin throughout the system downstream of Glens Falls, New York, paying considerable attention to persistent contaminants, such as heavy metals, polychlorinated biphenyls (PCBs), pesticides and anthropogenic radionuclides, which tend to accumulate in fine-grained sediments and can continue to mix with the water for many decades. In collaboration with Mount Sinai School of Medicine, the group has also investigated levels of lead, mercury and chlorinated organics in people who have consumed appreciable amounts of fish and shellfish from the Hudson.

Hudson History

The marshes are among the most crucial places in the Hudson, as they form the base of the food chain, protect young plants and animals, and protect the shoreline. Recently, Dorothy Peteet and her colleagues examined the vegetational and charcoal content of the marshes and found that over the last 4,000 years, these marshes have been strongly affected by drought. The Hudson's marshes are repositories of historic information about the regional New York climate and are especially valuable because they have a high sedimentation rate, which makes detailed sampling possible.

As part of a larger effort at the Observatory to understand the evolution of the Hudson Estuary and regional climate, Cecilia McHugh, Stephen Pekar and Lloyd Burckle are evaluating climate variability for the Hudson Valley for the past 6,000 years. They are estimating past salinity changes and fluctuations in freshwater discharge rates into the Hudson River using three proxies for salinity: diatom assemblages, foraminiferal biofacies and oxygen isotopes.

1. An image of a fossil oyster bed in the Hudson River taken with a sediment profiling imager. Credit: National Oceanic and Atmospheric Administration Coastal Services

1.


Calibration to historical precipitation records that go back to the late 1800s shows a correlation to the pronounced mid-1960s and early 1970s droughts in the northeast United States. Documentation of historical droughts in the Hudson Valley will help scientists to understand future climate change and to evaluate the impact of anthropogenic activities on the environment.

In the summer of 2001, Suzanne Carbotte and other Observatory scientists sited and recovered deep samples from the ancient glacial lake that once flooded the Hudson Valley. Scientists identified the distinctive signature of the glacial deposits in the seismic data acquired in the spring. With assistance from a local utility company, samples from the glacial lake were recovered and are now being analyzed at the Observatory's Core Laboratory. Scientists are looking for evidence of climatic cycles and the river's response to changing climate.

Carbotte is also examining the evolution of oyster populations in the Hudson River. Although oysters are not present today, researchers have dated shell remains found in the Hudson from 600 to 2,500 years old and from 5,000 to 6,500 years old. Cores taken from the oyster beds reveal abrupt changes in sediments, resulting from sea level rise and climate change. From these cores, researchers have determined that oysters disappeared in the Tappan Zee region during cooler times, possibly due to more severe winters with extensive freezing and ice rafting within the river. In more modern times, the demise of oysters may be associated with the Little Ice Age, although pollution and over harvesting appear to have contributed to the early-20th-century demise of oysters within New York Harbor.

The Pulse of the River — A Riverscope

In the fall of 2001, Martin Visbeck and Robin Bell, working with Observatory engineers, installed the first node of a riverwide monitoring station just south of the Tappan Zee Bridge. The initial installation includes atmospheric observations, river observations and observations from sensors beneath the water surface. Real-time monitoring of the Hudson River may have widespread impact upon policy development and the prediction of short- and long-term impacts of environmental changes. Salt front movement and its relation to urban water supplies, PCB dredging in the upper Hudson and its impact on the entire river and estuary, and the invasion of exotic species such as zebra mussels and the subsequent shifts in local and regional ecosystems will be some of the issues studied. Other studies will focus on land-use impacts and the implications of climate change on the Hudson River and its surroundings.

2. Peter Schlosser and David Ho measuring a trace gas in the Hudson River used to study the movement and mixing of water and how dissolved contaminants might be transported and dispersed. Credit: Carlos René Perez

3. Lloyd Burckle, Cecilia McHugh and Steve Pekar are evaluating the long-term drought record of the Hudson Valley by studying salinity changes in river sediments using diatom assemblages. Diatoms are minute planktonic algae whose presence changes with changes in water salinity. The graph shows an increase in salt-water assemblages in correlation to historical droughts. Credit: Burckle, McHugh and Pekar

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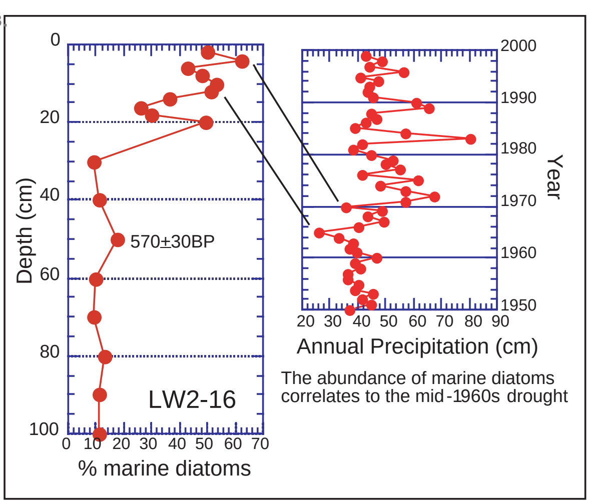


2.


Managing Risk in an Uncertain World

Despite significant scientific and engineering advances, global losses from natural hazards continue to rise, in large part due to the limited access of planners and policymakers to information and technological resources. With the establishment of the Center for Hazards and Risk Research, a diverse group of scientists from the Observatory and Columbia are designing new methods for assessing natural hazard risk and are helping communities around the world design strategies for reducing their vulnerability. The Center is currently conducting a number of research programs and projects focused on risk assessment, reduction and management.

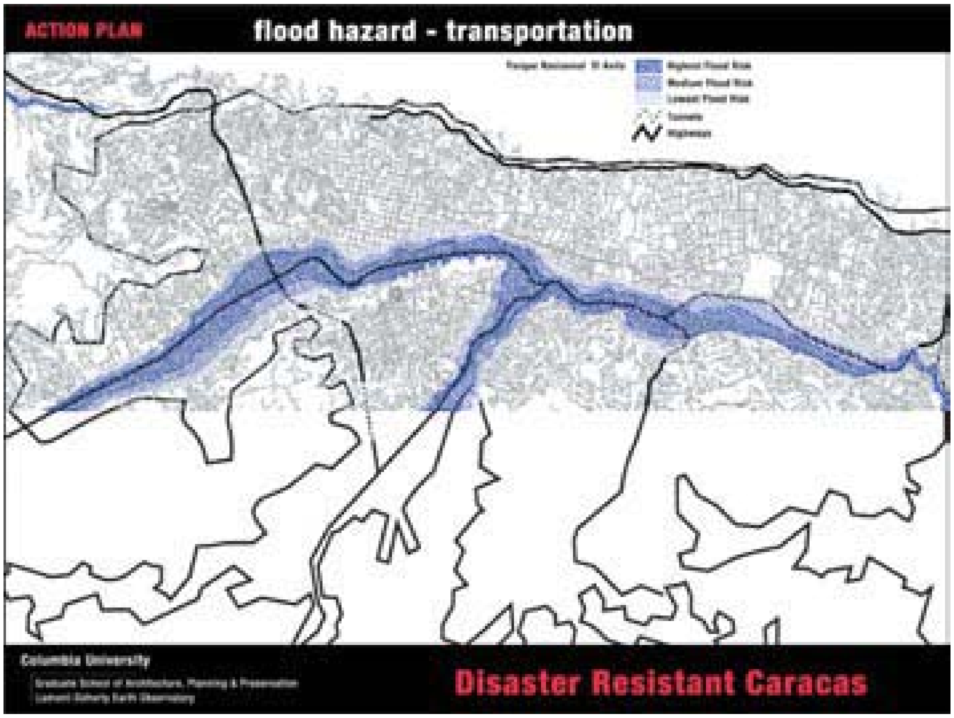

1.

Global Natural Disaster Risk Hotspots

In partnership with the World Bank, the Center is developing a global index of natural disaster hotspots. Led by Bob Chen of the Center for International Earth Science Information Network and Maxx Dilley of the International Research Institute for Climate Prediction, this project is establishing consistent methodologies for acquiring loss data and for quantifying physical vulnerabilities and response capacities. These new methodologies will help planners and policymakers develop a uniform approach for targeting the most vulnerable places in the world and thus reduce risk with appropriate preventive measures.

Urban Planning Studios

Led by SG&T scientist Klaus Jacob and Sigurd Grava from Columbia's Graduate School of Architecture, Planning and Preservation, these studios join students and faculty from the Observatory with those from Columbia's graduate program in Urban Planning, who are asked to incorporate natural hazard risk assessment into planning and development guidelines for major urban areas around the world. Two studios in Caracas, Venezuela, and Istanbul, Turkey, have been completed, and both have led to continuing risk reduction work in these two municipalities. Another studio focusing on Accra, Ghana, in Africa is planned for 2003.



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1. The tremendous force of flood waters is evidenced by the partial collapse of a hotel in downtown Caracas. Credit: Graduate School of Architecture, Planning and Preservation
2. Students produced a number of hazard analyses in the Caracas Urban Planning studio, including how flood hazard might affect transportation routes. This map illustrates the vlnerability of the city's major transportation arteries to floods. Credit: Graduate School of Architecture, Planning and Preservation
3. Klaus Jacob (left) and Sigurd Grava (center) meet with an official of the Caracas municipality after presenting the planning studio's results. Credit: Graduate School of Architecture, Planning and Preservation


3.

1. The 1999 earthquake sequence in Turkey caused massive loss of life and property. Observatory scientists led the aftershock survey, collecting the data that will help Turkey reduce losses associated with future earthquakes. Credit: Nano Seeber and John Armbruster

Landslides

Colin Stark and Jeffrey Weissel from the geomorphology and remote sensing laboratories at the Observatory are developing advanced probability models for the natural mechanisms that affect the frequency, size and distribution of landslides triggered by extreme seismic and climate events in California, Taiwan, Italy and other locations worldwide. Collaboration with these labs has resulted in a project to develop new approaches for mapping natural disasters such as landslides, volcanic eruptions and wild fires using synthetic aperture radar polarimetry. Ultimately, researchers hope to provide a radar-based system that will allow for better assessment of these types of natural disasters.

Istanbul Retrofit Study

The next earthquake near Istanbul is expected to occur on a segment of the North Anatolian Fault just south of the city. Unfortunately, some of the most vulnerable structures in Istanbul are the multistory residential apartments built in the last few decades. With seed funding from the Center, earthquake engineers George Deodatis and Andrew Smyth from Columbia's Department of Civil Engineering and Engineering Mechanics are currently working with Observatory seismologists led by Nano Seeber, partners from Bosporous University and Kandilli Observatory in Turkey and the University of Pennsylvania's Wharton School of Business to understand the benefits and costs of retrofitting measures that could reduce the vulnerability of these buildings. Researchers are currently using residential surveys to understand the attitudes of apartment dwellers and their willingness to adopt mitigation measures.

Marine Paleo Seismology on the North Anatolian Fault

Turkey endured a series of disastrous earthquakes in 1999 that broke segments of the North Anatolian Fault east of Istanbul. Seismologists have hypothesized that these earthquakes have loaded the next segment just west of the 1999 rupture, south of Istanbul in the Sea of Marmara. Using new high-resolution sonar instruments, SG&T seismologist Nano Seeber worked with Milene Cormier and Bill Ryan in MG&G to demonstrate that high-resolution sonar surveys of the marine segment of the fault could detect disruption in the sediments resulting from past earthquakes. This initial survey demonstrated conclusively which of the many strands of the North Anatolian Fault under the Sea of Marmara have broken in the past and may be likely to break in the future. Marine paleo seismology promises to revolutionize the study of continental borderlands and to allow scientists to estimate future earthquakes more accurately when faults lie offshore in shallow water.

Columbia-Wharton Roundtable

The Center was honored to have Howard Kunreuther from the University of Pennsylvania's Wharton School of Business as its first visiting researcher in 2001–2002. After the events of September 11, the Center's mission took on a special resonance. Kunreuther and Art Lerner-Lam, the Center's interim director, organized a Columbia-Wharton Roundtable: "Risk Management Strategies in an Uncertain World." Held in April 2002, the roundtable attracted a diverse group of experts from universities and private companies from around the country to help formulate a new, multi-institutional research agenda for managing risk from extreme events.

Special Events and Awards

U.S.N.S. *Bruce C. Heezen* Open House and Tour of the United States Navy's newest oceanographic survey ship

The Intrepid Pier, August 4, 2000

The public and Columbia University community alike were invited to tour the Navy's newest oceanographic survey ship, U.S.N.S. *Bruce C. Heezen*, in port at the *Intrepid* berth in New York City. The ship's namesake, Bruce C. Heezen, a past member of the Columbia University faculty and a researcher at the Observatory, was known for his pioneering work in plate tectonics and the famous Heezen-Tharp physiographic maps of all the major oceans of the world. At a special reception held for the Lamont community, John C. Mutter, then interim director of the Observatory, accepts a memento from a Navy representative. Special tours of the ship were also arranged for participants of the Bayside YMCA Summer Teen Camp and Lamont alumni.

The Observatory's R/V *Maurice Ewing* made a rare visit to New York and was open for tours at New York City's Water Club. Technician Karl Hagel (left, at right) explains the bathymetric data displayed on a flat bed recorder in the Instrument Lab to a visitor. Marine Science Coordinator John Diebold (center, at left) discusses the *Ewing's* recent research endeavors with Lamont alumni. A reception at the Water Club followed.

R/V *Maurice Ewing* Open House and Tour

The Water Club, August 23, 2000

New York City Underwater? Storm Surge Risks in the Face of Rising Sea Level

Klaus Jacob
LDEO Public Lecture Series
Lamont Campus, April 1, 2001

Klaus Jacob, a research scientist at the Observatory, spoke about climate change–induced sea-level rise and how it could impact the Metropolitan East Coast (MEC) region and the transportation infrastructure that serves the greater New York City metropolitan area. Here, he fields questions on the risks to the MEC's transportation systems from coastal storm surges and the impact on residents of coastal areas. The other speakers in the 2001 Public Lecture series were Roger N. Anderson, Dee Breger, Richard Fairbanks and Wallace Broecker.

July 1, 2000 – June 30, 2001

U.S.N.S. *Bruce C. Heezen* Open House and Tour of the United States Navy's oceanographic survey ship
The *Intrepid* Pier
August 4, 2000

R/V *Maurice Ewing* Open House and Tour
The Water Club
August 23, 2000

Lamont-Doherty Earth Observatory Annual Open House
Lamont Campus
October 7, 2000

New York City Underwater?
Storm Surge Risks in the Face of Rising Sea Level
Klaus Jacob
Lamont-Doherty Earth Observatory Public Lecture Series
Lamont Campus
April 1, 2001

Out of Power, Out of Time
The Energy Crisis of 2001: Its Origins and Future Outlook
Roger N. Anderson
Lamont-Doherty Earth Observatory Public Lecture Series
Lamont Campus
April 22, 2001

From Oceans to Asteroids:
Revelations from the Electron Microscope
Dee Breger
Lamont-Doherty Earth Observatory Public Lecture Series
Lamont Campus
May 6, 2001

Coral Reefs: Archives of Earth's History
Richard Fairbanks
Lamont-Doherty Earth Observatory Public Lecture Series
Lamont Campus
May 20, 2001

Planetary Stewardship: What Do We Do about Fossil Fuels?
Wallace Broecker
Lamont-Doherty Earth Observatory Public Lecture Series
Lamont Campus
June 3, 2001

Lamont-Doherty Earth Observatory Annual Open House

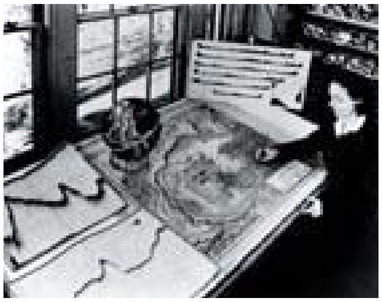
Lamont Campus
October 7, 2000

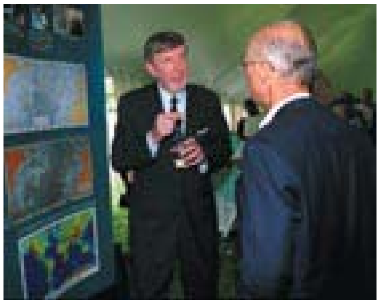
The public and the Columbia University community were invited to the Lamont-Doherty Earth Observatory's Annual Open House. A future scientist peaks through the Tree Ring Lab's logo before going into the lab to learn about the stories embedded in tree rings, corals and deep-sea sediment cores. Below right, Marc Spiegelman elaborates on Bathtub Science and below left, Sidney Hemming, Kyla Simons, Alberto Saal, Katie Donnelly and Steve Goldstein pose in their Open House tee-shirts, which show a map of the 12,000 worldwide locations and 42 miles of ocean-bottom cores that are stored on the Lamont campus in the Observatory's Deep-Sea Sample Repository.

Lamont-Doherty Earth Observatory Heritage Award

Marie Tharp
Lamont Campus
July 17, 2001

Director Michael Purdy is pictured below left with Marie Tharp as she is awarded the first Lamont-Doherty Heritage Award. Just a few weeks short of her 81st birthday, the mother of modern ocean floor cartography was honored by Columbia University for her life's work. It was through Tharp's astute observations (center, in Lamont Hall, c. 1961) that the Atlantic Rift Valley was first discovered, which paved the way for acceptance of the theories of plate tectonics and continental drift. At right, Purdy talks to a Lamont alumnus about Tharp's major contribution: the first detailed maps of the ocean floor around the globe based on sonar, which have since become modern scientific icons.





LDEO First Annual Excellence in Mentoring Award

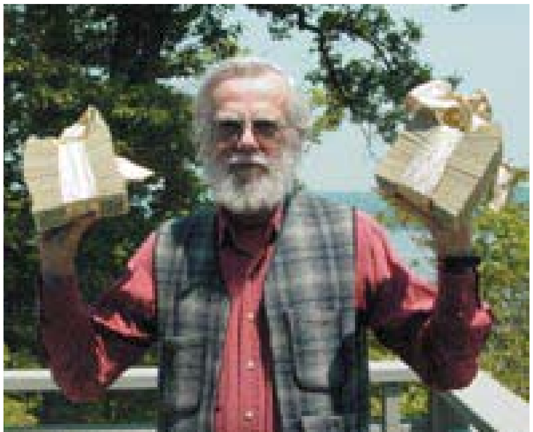
Sidney Hemming
Lamont Campus
September 26, 2001

The Lamont-Doherty Excellence in Mentoring Award was established in 2001 to recognize the importance of quality mentoring, which benefits the institution as a whole, its young scientists and their mentors. Sidney Hemming (left), receiving her $2,000 cash prize from Director Michael Purdy, was the first recipient of the award. An assistant professor of Earth and Environmental Sciences, Sidney Hemming was selected for her work and devotion to advancing the careers of junior scientists. Credit: Doug Brusa

LDEO Second Annual Excellence in Mentoring Award

Gordon Jacoby
Lamont Campus
May 24, 2002

The Second Annual Lamont-Doherty Excellence in Mentoring Award ceremony was held in Monell Auditorium on Friday, May 24, 2002. The recipient, Dr. Gordon Jacoby of the Tree Ring Laboratory, is pictured here (left), prize in hand and with Nicole Davi and Rosanne D'Arrigo (center) at the awards ceremony. Personal observations about Gordon's longstanding excellence in mentoring were given by Neil Pedersen and Nicole Davi.



July 1, 2001 – June 30, 2002

Lamont-Doherty Earth Observatory Heritage Award
Marie Tharp
Lamont Campus
July 17, 2001

Lamont-Doherty Earth Observatory First Annual Excellence in Mentoring Award
Sidney Hemming
Lamont Campus
September 26, 2001

Lamont-Doherty Earth Observatory Annual Open House
Lamont Campus
October 6, 2001

**A Sea of Change:
Decade-scale Biogeochemical Variability in the North Pacific Subtropical Gyre**
David Karl
W.S. Jardetsky Lecture
Lamont Campus
February 21, 2002

Is It Safe? Natural Disasters, Terrorism, Vulnerability and Response
Panel moderated by Arthur Lerner-Lam,
Interim Director of the Center for Hazards and Risk Research
LDEO Public Lecture Series
Lamont Campus
April 21, 2002

Arsenic Poisoning Mystery Revealed: University Team Proposes Solutions to Tragedy in Bangladesh
Panel discussion with: Alexander van Geen,
Malgosia Madajewicz, Habibul Ahsan
LDEO Public Lecture Series
Lamont Campus
April 28, 2002

How Old is Earth and How Do We Know?
Steven Goldstein
LDEO Public Lecture Series
Lamont Campus
May 5, 2002

What Can Biosphere 2 in Tucson, Arizona, Teach Us about the Forests of New York and New Zealand?
Kevin Griffin
LDEO Public Lecture Series
Lamont Campus
May 19, 2002

Lamont-Doherty Earth Observatory Second Annual Excellence in Mentoring Award
Gordon Jacoby
Lamont Campus
May 24, 2002

Lamont-Doherty Earth Observatory Annual Open House

Lamont Campus
September 26, 2001

The Hudson River and Estuary was the focus of the 2001 Open House. The public also came to see how over 200 Observatory earth scientists and researchers are working to understand earthquakes, climate, oceans, arctic volcanoes and other mysteries of Earth. Exhibits were prepared by a host of Observatory scientists including (top, left to right) Bruce Shaw and Chris Walker who are seen demonstrating seismic monitoring equipment. Below clockwise: two young scientists displaying their Hudson River soil samples, Katie Donnelly of the Petrology department discussing rock samples with an interested visitor and Doug Brusa leading a campus tour. Credit: Ronnie Anderson

The Observatory's Beginnings

In a letter dated December 20, 1948, Mrs. Thomas W. Lamont, widow of the former chairman of J.P. Morgan, confirmed to President of Columbia University Dwight D. Eisenhower, that she intended to donate her weekend home "Torrey Cliff" to the University. She wrote, in part, "I am giving this property in my husband's memory. My gift is unrestricted," but she was pleased with the University's plans for the property as a center for geological research, assured that "the world [would] benefit." This was the first gift to what would soon become the Lamont Geological Observatory.

Although Thomas Lamont had gone to Harvard and was famous in his time for his philanthropy to that institution and others, Mrs. Lamont—born Florence Corliss—was a Columbia graduate. Thus, the main house, outbuildings and a 155-acre estate atop the Palisades came to Columbia.

Paul Kerr, the chair of the Geology department at the time, and Maurice "Doc" Ewing, soon to be the founding director of the Geological Observatory, were eager to move the department's research labs to a location near the Morningside Heights campus, but removed from the vibrations and interference there. While the new site seemed ideal, both were well aware of the cost of running the facility.

After conferring with her family, Mrs. Lamont agreed to make an additional gift of $200,000, as long as it was matched. President Eisenhower sought the support of a few Trustees and friends of Columbia and raised the matching funds. With $400,000 in hand, enough to start up the operation and help see it through its first six years, the Observatory was in business.

The Lamont family's generosity did not stop there. Thomas Lamont's second son, Corliss, had received his Ph.D. from Columbia in 1932 and was a longtime member of the Columbia faculty. He made innumerable gifts to many areas of the University, including the Observatory. In 1996, his will included a bequest for the Lamont Nature Sanctuary, an area adjacent to the original estate that will remain forever undeveloped.

In the second most important contribution to the Observatory, the Henry L. and Grace Doherty Charitable Foundation made a $7 million gift in 1968. The gift was intended to increase the Observatory's endowment, "primarily to increase the stability of employment of the staff of the Observatory, and to enlarge the opportunities available to them." Mr. Doherty had been the founder of Cities Service Company, a large oil and gas company. The foundation staff was well aware of the work of the Observatory's research scientists, having supported ocean sciences at several institutions. In recognition of the importance of such a gift, Columbia renamed the facility the Lamont-Doherty Geological Observatory, later to be called Lamont-Doherty Earth Observatory.

1.

The Endowment Today

Today, the endowment has grown large enough to help support the salaries of 54 scientists at the Observatory, from associate research scientists to senior scholars, much as the Doherty Foundation had intended. With this support, scientists are free to pursue their research with far less concern for the restrictions often imposed by traditional funding sources. Interdisciplinary research, in particular, becomes much more feasible.

Endowment of faculty and research positions is in fact one of the most prominent ways to honor or memorialize a donor while supporting the basic research that is the essence of the Observatory. The academic department—now called the Department of Earth & Environmental Sciences (DEES)—has five endowed positions: the Arthur D. Storke Memorial (held by Paul Olsen), Vetlesen (held by Mark Cane), Newberry (held by Wallace Broecker), Mellon (held by Paul Richards) and Higgins (held by Lynn Sykes) professorships. These endowments provide the same relief as the

1. A view familiar to Thomas and Florence Lamont and to the generations of Observatory staff who have followed, the front entrance to Lamont Hall.

1.

1. The driveway entrance to the former Lamont estate "Torrey Cliff" and new home of the Lamont Geological Observatory in 1949.

Doherty endowment; they help recruit and retain the finest scientists in the field. By reducing the need to generate grants in a specific field, groundbreaking, interdisciplinary work can be encouraged. Increasing the number and size of these endowments remains one of the Observatory's highest priorities.

Additional support has come from other sources as well over the years. Founded in 1970 by Lamont-Doherty researchers, the Palisades Geophysical Institute (PGI) has conducted important scientific research for the United States government and provided important support to the Observatory. PGI has endowed a senior research scientist, an associate research scientist, and a professorship in the Earth and Environmental Engineering department. The Institute has provided important programmatic support for many years as well.

Corporate and Foundation Support

For decades, through Lamont-Doherty's industrial associates program, oil companies across the globe supported the Observatory's petrology and marine exploration initiatives, and provided critical unrestricted support as well. With ongoing mergers and intensified cost cutting, however, the oil companies' research operations have been cut drastically, as has their support of institutions like Lamont-Doherty. The Observatory has been extremely fortunate to replace that support through the generosity of the G. Unger Vetlesen Foundation. Founded by a Norway-born shipbuilder, cruise ship operator and airline industry executive, the Vetlesen Foundation is one of the largest funders of oceanographic and environmental science institutions of higher learning.

In addition to providing much-needed operating support, the Vetlesen Foundation endowed an academic chair and has sponsored the Vetlesen Prize and Dinner, which since 1959 has honored the world's most renowned Earth scientists. In recent years, the Observatory has also enjoyed the support of the Ambrose Monell Foundation, for which the Observatory's newest building was named in 1998, as well as of the Ford Motor Company, Apache Corporation and others.

Over the years, several efforts have been made to reach out to Lamont-Doherty alumni and neighbors. In 1995, the Observatory mounted a campaign to restore the campus fountain. More than 200 gifts poured in, in response to a single letter, enabling the institution to move forward on the restoration project. The Observatory celebrated its 50th anniversary in 1999, with a series of events and the publishing of a commemorative book. A number of donors made gifts to mark the occasion.

Looking to the Observatory's Future

In 1996, Columbia University established The Earth Institute, combining the Lamont-Doherty Earth Observatory with other Columbia centers and faculty in engineering and in earth, social and health sciences. The Earth Institute signals publicly the University's commitment to the importance of Earth sciences and sustainable development. It has also made it clear that significant new resources need to be developed if The Earth Institute and its component units are to thrive. As the oldest and largest unit, the Observatory must build on its record of philanthropic support. If the Observatory is to continue its role of providing the research and the science upon which strategies for sustainable development can be built, it will need new and renovated facilities, increased endowments and targeted program support.

In an effort to communicate more directly with former students, researchers and staff, the Observatory has formed an Alumni Association. In November 2001, the Observatory made its first annual appeal and enjoyed a heartening response. The Observatory's future as a superior research facility and the core of The Earth Institute's mission depends on the continued generous support of Lamont-Doherty alumni, friends and neighbors.

2.

2. Looking beyond one of the two eagles that stand guard at the pathway entrance to the campus gardens in front of Lamont Hall.

Lamont-Doherty Alumni Association

From the time of its founding in 1949 as the Lamont Geological Observatory, hundreds of students, scientists and staff have passed through the grounds, laboratories and research vessels of the Lamont-Doherty Earth Observatory. Some earned academic degrees here. Others built instruments or operated them in the field or at sea. Still others performed laboratory research, computer programming or the countless other tasks required to support the Observatory's mission and accomplishments.

What many of these people have in common is a deep and lasting affection for the place with the long hyphenated official name, which they simply call "Lamont." They call themselves "Lamonters."

As a result of the Observatory's 50th anniversary celebrations and events, a group of Lamonters created the Lamont-Doherty Alumni Association. Unlike the typical alumni association model of limiting membership to academic degree recipients, the Lamont association includes all who worked or studied here at some point in the past and who wished to renew connections. It is an inclusive "big family" model, much like the Observatory itself.

Shortly after the anniversary celebrations, a group of Lamonters including Terry Edgar, Joe Worzel, Arnold Finck, Bill Ryan, George Sutton, Denny Hayes and the Observatory's interim director, John Mutter, circulated surveys, held meetings and worked with University administrators to form the association. Their efforts paid off. In 2000, the Lamont-Doherty Alumni Association was established with Terry Edgar as its first president.

The purpose of the Lamont-Doherty Alumni Association is to advance the interest and promote the welfare of Lamont-Doherty Earth Observatory, as well as to foster communications and interactions among its alumni. The membership includes past Lamont-Doherty graduate students, postdoctoral fellows, scientists, visiting scholars and former employees.

In its early years, the Alumni Association has fostered communications through a regularly published newsletter and Web site, which includes alumni updates and news from the association president and Observatory director. Feedback from the membership has been positive. The Association has hosted a very popular reception at the annual meeting of the American Geophysical Union in San Francisco.

Under its second president, P. Jeffrey Fox, the Association has expanded its efforts to include informative alumni meetings and State-of-the-Observatory presentations at both the Lamont Open House and American Geophysical Union meetings.

1. P. Jeffrey Fox, Director of the Ocean Drilling Program at Texas A&M University and the second president of the Lamont-Doherty Alumni Association.
2. The Alumni Association Newsletter's Summer 2002 edition. The newsletter is published twice a year and is mailed to all known faculty, employee and student alumni, as well as to friends of the Observatory.


Alumni

1.

2.

A New Annual Alumni Fund

1.

1. Director G. Michael Purdy (left) with Terry Edgar of the U.S. Geological Survey (center) and P. Jeffrey Fox (right). Edgar served as the first president of the Lamont-Doherty Alumni Association. Fox is the current president.
2. W. Maurice “Doc” Ewing, (1906–1974), founder of the Lamont Geological Observatory and its first director.
3. One of the many lectures held in Lamont Hall, the Lamont Geological Observatory’s first home, in the mid-1950s.

At the Lamont-Doherty Earth Observatory’s 50th anniversary, many alumni and friends joined in celebrating the Observatory’s distinguished record of scientific achievement. Time and again, visiting alumni expressed interest in the current work and future health of the Observatory and a willingness to renew their connections to Lamont.

In November 2001, the Observatory established its first-ever annual solicitation of financial support from alumni. Director Michael Purdy and Alumni Association President P. Jeffrey Fox sent their first annual appeal to 1,250 alumni and friends in nearly all 50 states and 36 foreign countries. The list drew on academic alumni lists, registration rosters from the 50th anniversary celebrations and inquiries made by alumni.

More than 100 alumni responded with contributions, an encouraging response. Some contributors took advantage of matching-gift programs offered by their employers. Some made their donations on line. All provided resources to the Observatory that would not have been otherwise available.

In response to the recognition that the Observatory needed to reach out to neighbors and friends, as well as alumni, the Lamont Public Lecture Series was begun in the spring of 1999. The series features talks by Lamont scientists on Earth science topics designed for a general audience. Held on campus in the spring, generally on Sunday afternoons, these talks have been well received and well attended. When asked to support the cost of the lectures, many attendees responded generously with a contribution.

Alumni and friends who appreciate the great value of the work done at the Observatory—and who know government funds will not pay all the costs—play an invaluable role in supporting promising initiatives that connect the Observatory to a wider audience.

2.

3.

Administration

Jeff Shapiro, Director of Administration
Assistant Director of the Lamont-Doherty Earth Observatory

The administration of the Lamont-Doherty Earth Observatory takes pride in its mission to serve the operating needs of the Observatory's world-class researchers. Located across the Hudson River north of the main campus in Morningside Heights, the Observatory requires a separate but coordinated administrative staff to maintain effective and efficient operations. Though formally an extension of Columbia University's central operations, the Observatory's administration is able to offer direct, on-site services to the research community on the Lamont campus.

The Observatory's administration is organized around a set of core functions including Grants & Contracts, Finance & Accounting, Human Resources, Procurement, Facilities Management, Shipping & Traffic, Security and central management. Additional ancillary operations encompass a copy center, housing, food service and a variety of related functions.

Within the various research divisions, division administrators provide the vital link between scientific activities and core administrative services necessary to support those operations. By familiarizing themselves with the creative research environments unique to each division, these administrators are able to offer the appropriate support.

One of the primary responsibilities of administration is to maintain the financial and mandatory requirements of any grant or contract without being overly burdensome or interfering with the institution's primary research activities. Our skilled and devoted support staff make this possible and continue to contribute to the Observatory's success in myriad ways.

The Observatory's senior adminsitrative staff. From left to right: Ray Long, Doug Brusa, Dick Greco, Mary Mokhtari, Tom Eberhard, Pam Stambaugh, George Papa and Jeff Shapiro.

Lamont-Doherty Earth Observatory

Statement of Changes in Fund Balances for Fiscal Year 2002

July 1, 2001 – June 30, 2002

	Grants	Gifts	Endowment Income	Endowment Principal	Institutional Support	Total FY02	Total FY01
REVENUES							
Government Grants & Contracts							
National Science Foundation	17,156,453					17,156,453	18,164,575
Subcontracts	8,828,208					8,828,208	10,135,222
National Oceanic and Atmospheric Administration	2,648,863					2,648,863	1,504,890
National Aeronautics and Space Administration	1,412,136					1,412,136	1,578,431
Defense Threat Reduction Agency	1,122,551					1,122,551	1,469,873
National Institutes of Health	890,674					890,674	
Office of Naval Research	550,928					550,928	1,332,121
Miscellaneous	252,844					252,844	122,100
U.S. Geological Survey	218,869					218,869	569,154
N.Y. Department of Environmental Conservation	0					0	1,727,041
Department of Energy	0					0	9,058
Private Grants & Contracts	1,434,640					1,434,640	348,555
Gifts		1,063,558				1,063,558	1,032,851
Investment Income		41,833	3,428,760			3,470,593	2,898,488
Realized Gain (Loss)				(590,480)		(590,480)	3,345,369
Change in Unrealized Gain (Loss)				(1,769,969)		(1,769,969)	(4,075,287)
Other Sources		14,632		0	1,399,763	1,414,395	1,530,941
Total Revenues	**34,516,166**	**1,120,023**	**3,428,760**	**(2,360,449)**	**1,399,763**	**38,104,263**	**41,693,382**
EXPENDITURES							
Sponsored Research Expenditures	20,085,355					20,085,355	19,711,177
Administrative & Facility Costs	7,563,793				332,058	7,895,851	7,326,057
Marine Expense Recovered by Grants	7,901,752					7,901,752	5,004,517
Marine Recovery in Excess of Expense	(933,707)					(933,707)	1,902,460
Research Support Expenditures		843,714	2,024,384		564,768	3,432,866	2,813,343
External Affairs & Fund-raising		81,274	484,727			566,001	500,642
Ancilliary Services					256,069	256,069	255,657
Plant (Capital) Expenditures					525,818	525,818	1,355,056
Internal Grants & Seed Funding Expenditures		14,632			1,784,481	1,799,113	1,717,314
Total Expenditures	**34,617,193**	**939,620**	**2,509,111**	**0**	**3,463,194**	**41,529,118**	**40,586,223**
TRANSFERS							
Transfer among Funds		743,363	(740,156)	(2,610,154)	2,974,886	367,939	1,225,213
Budget Adjustments: Close Out Grants	(53,630)					(53,630)	(26,928)
Grant Carryforwards Adjustments	(1)	(1)	1,087,991				
Total Transfers	**(53,631)**	**743,363**	**(740,156)**	**(2,610,154)**	**2,974,886**	**314,308**	**2,286,276**
Net Increase (Decrease) for the Year	(154,658)	923,766	179,493	(4,970,603)	911,455	(3,110,547)	3,393,435
Fund Balance at Beginning of Year	25,691,826	1,854,755	586,311	77,027,130	1,925,102	107,085,124	103,691,689
Fund Balance at End of Year	25,537,168	2,778,521	765,804	72,056,527	2,836,557	103,974,577	107,085,124

Staff Listings

DIRECTOR'S OFFICE

Purdy, G. Michael	Director
Mutter, John C.	Executive Deputy Director
Shaterian, Lyn	Assistant to the Director
Wuerfel, Beverly	Coordinator
Colwell, Miriam G.	Administrative Assistant

BIOLOGY AND PALEO ENVIRONMENT

Marra, John F.	Associate Director
Hoffer, Karen	Division Administrator

SENIOR SCIENTIFIC STAFF

Bond, Gerard C.	Doherty Senior Scholar
Cook, Edward R.	Doherty Senior Scholar
D'Arrigo, Rosanne D.	Doherty Senior Research Scientist
deMenocal, Peter B.	Assistant Professor
Fairbanks, Richard G.	Professor
Griffin, Kevin L.	Assistant Professor
Hays, James D.	Professor
Lynch-Stieglitz, Jean	Assistant Professor
Marra, John F.	Doherty Senior Scholar
Olsen, Paul E.	Arthur D. Storke Memorial Professor
Sambrotto, Raymond N.	Doherty Research Scientist
VanGeen, Alexander	Doherty Senior Research Scientist

RESEARCH STAFF

Buckley, Brendan M.	Doherty Associate Research Scientist
Langdon, Christopher	Doherty Associate Research Scientist
Liepert, Beate G.	Doherty Associate Research Scientist

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Marchitto, Thomas M.	Postdoctoral Research Scientist
Prieto-Galvez, Laura	Postdoctoral Research Fellow
Stickley, Catherine	Postdoctoral Research Fellow
Vaillancourt, Robert D.	Postdoctoral Research Scientist

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Chase, Zanna
Chiu, Tzu-chien
Cooney, Kevin
Engel, Victor
Farmer, Christa
Geisler, Jonathan
Green, Sara E.
Greene, Arthur
Hwang, Sunny H.
Ingram, Sarah J.
Koutavas, Athanasios
LeGrande, Allegra N.
Machlus, Malka L.
Makovicky, Peter
Malinconico, Mary Ann
Mihlbachler, Matthew C.
Nagel, Jennifer M.
Pederson, Dorothy C.
Pederson, Neil
Pol, Diego
Potosnak, Mark
Rainforth, Emma
Rothwell, Tom
Salkowski, Nick
Shapiro, Josslyn
Takesue, Renee
Whiteside, Jessica
Xu, Chengyuan

SPECIAL RESEARCH SCIENTISTS

Hunkins, Kenneth L.
Jacoby, Gordon C.
Kukla, George

LDEO ADJUNCTS

Anderson, O. R.	Adjunct Senior Research Scientist
Burckle, Lloyd H.	Adjunct Senior Research Scientist
Carlut, Julie H.	Adjunct Associate Research Scientist
Cherubini, Paolo	Adjunct Research Scientist
Garzoli, Silvia L.	Adjunct Senior Research Scientist
Gastrich, Mary D.	Adjunct Research Scientist
Gavrieli, Ittai	Adjunct Associate Research Scientist
Heusser, Linda E.	Adjunct Research Scientist
Holland, David M.	Adjunct Associate Research Scientist
Kent, Dennis V.	Adjunct Senior Research Scientist
LeTourneau, Peter M.	Adjunct Associate Research Scientist
Lohmann, Ulrike	Adjunct Associate Research Scientist
Nachin, Baatarbileg	Adjunct Associate Research Scientist
Orwig, David A.	Adjunct Research Scientist
Peteet, Dorothy M.	Adjunct Senior Research Scientist, Lecturer
Ray, Bonnie K.	Adjunct Research Scientist
Reverdin, Gilles P.	Adjunct Associate Research Scientist
Reynolds, David J.	Adjunct Research Scientist
Robinson, David A.	Adjunct Research Scientist
Rose, Jerome	Adjunct Associate Research Scientist
Rousseau, Denis-Didier	Adjunct Associate Research Scientist
Seemann, Jeffrey R.	Adjunct Senior Research Scientist
Smith, Stanley D.	Adjunct Senior Research Scientist
Sues, Hans-Dieter	Adjunct Senior Research Scientist
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Turnbull, Matthew H.	Adjunct Research Scientist
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Broecker, Wallace S.	Newberry Professor
Goldstein, Steven L.	Associate Professor
Hemming, Sidney R.	Assistant Professor
Longhi, John	Doherty Senior Research Scientist
Schlosser, Peter	Professor
Simpson, Harry J.	Professor
Smethie, William M.	Doherty Senior Research Scientist
Takahashi, Taro	Doherty Senior Scholar, Adjunct Professor
Walker, David	Professor

RESEARCH STAFF

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Donnelly, Kathleen E.	Postdoctoral Research Scientist
Ho, David T.	Postdoctoral Research Scientist
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Murray, James T.	Senior Research Staff Assistant
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Martinson, Douglas G.	Doherty Senior Research Scientist, Adjunct Professor
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Stieglitz, Marc	Doherty Associate Research Scientist
Susanto, Raden D.	Doherty Associate Research Scientist
Tremblay, Bruno	Doherty Associate Research
Scientist,	Storke Doherty Lecturer
Yuan, Xiaojun	Doherty Associate Research Scientist

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Grieco, Luisa	Postdoctoral Research Fellow
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LDEO ADJUNCTS

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Li, Cuihua	Systems Analyst/Programmer
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Rosen, Lawrence S.	Senior Systems Analyst/Programmer

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Newberger, Timothy A.	Senior Marine Development Technician
Tubiana, Felix A.	Research Staff Assistant
Velez, Edgar	Lab Technician
Went, Ellen G.	Administrative Assistant

SEISMOLOGY, GEOLOGY AND TECTONOPHYSICS

Lerner-Lam, Arthur L.	Associate Director
Mayer, Bonnie J.	Division Administrator

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Lerner-Lam, Arthur L.	Doherty Senior Research Scientist, Adjunct Professor
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Richards, Paul G.	Mellon Professor of Natural Science
Scholz, Christopher H.	Professor
Seeber, Leonardo	Doherty Research Scientist
Shaw, Bruce E.	Doherty Research Scientist
Spiegelman, Marc W.	Associate Professor
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Hagel, Karl	Senior Electronic Technician
Leidhold, Christopher P.	Senior Electronic Technician

MARITIME

Batchelor, John A.	Cook
Braniff, Marcella	Able-Bodied Seaperson
Brannon, William M.	Ordinary Seaperson
Byrne, John G.	Air Gun Engineer – Temporary
Doughty, Daniel	Ordinary Seaperson
Ells, Cheryl	Cook – Temporary
Ewing, Robert E.	Able-Bodied Seaperson
Florendo, Rodolfo A.	Oiler
Flores, Miguel A.	Second Assistant Engineer
Greenberg, Jacob	Able – Bodied Seaperson
Guevarra, Mervin	Able-Bodied Seaperson – Temporary
Hathorne, Robert	Oiler
Hickey, Thomas	Third Assistant Engineer – Temporary
Hontiveros, Felepe	Able-Bodied Seaperson – Temporary
Karlyn, Albert D.	Chief Engineer
Landow, Mark C.	Master
Lee, Daniel S.	Oiler – Temporary
Logue, Gregory	Third Assistant Engineer – Temporary
Maiwiriwiri, Ropate Q.	Core Bosun
Matos, Francisco N.	Chief Marine Electrician
McGeough, Scott S.	Second Mate – Temporary
McNeal, Frederick L.	Ordinary Seaperson
Mecketsy, Meredith J.	Third Mate
Moqo, Luke	Messperson
Neill, Nicholas	Second Assistant Engineer – Temporary
Noonan, Megan	Able-Bodied Seaperson
O'Loughlin, James E.	Master
Philbrick, David L.	Bosun
Pica, Stephen M.	Chief Engineer
Potts, Alfred W.	Oiler – Temporary
Scanland, Elizabeth B.	Able-Bodied Seaperson – Temporary
Schwartz, John H.	Chief Marine Electrician
Smith, John S.	Steward
Syferd, Jim	Ordinary Seaperson
Sypongco, Arnold A.	Ordinary Seaperson
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Thomas, Jay	Chief Mate – Temporary
Thomas, Richard N.	Third Mate
Tomas, Kelly F.	Bosun
Tucke, Matthew S.	First Assistant Engineer
Uribe, Guillermo F.	Oiler
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Wilson, Scott	Able-Bodied Seaperson
Wolford, David H.	Second Mate
Zeigler, Stanley P.	Chief Mate
Ziencik, Michael	Oiler

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Hicks, Linda D.	Budget Assistant
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Mounier, Cyndi A.	Administrative Aide
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Sheridan, Linda J.	Supervisor
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Tavarone, Virginia P.	Financial Services Assistant

BUILDINGS AND GROUNDS

Greco, Richard E.	Manager
Baez, Bruce	A Mechanic
Casilli, Joseph	A Mechanic
Jones, Charles	A Mechanic
Muench, Herbert	A Mechanic
Murray, Jacqueline R.	Administrative Aide
Soto, Eric	B Mechanic
Sullivan, Kevin	A Mechanic
Valenti, Joseph	A Mechanic
Vazquez, Hector	A Mechanic
Went, Wayne	Head Mechanic

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Dillon, Dawn M.	Food Services Assistant

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Lichtblau, Laura A.	Project Coordinator
Respo, Maribel	Contracts Coordinator
Ruane, Patricia	Administrative Aide
Sosa, Lauren	Project Coordinator

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Domenick, Joanne E.	Assistant Manager Human Resources
Medina, Cynthia	Human Resources Assistant

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DiBernardo, John G.	Senior Mechanical Technician
Gallagher, Bernard D.	Senior Electronic Technician

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Deutsch, Bonnie L.	Assistant to Manager
Anderson, Ronnie H.	Administrative Aide
Clinton, Carol L.	Administrative Aide
Schmidt, Ronald	Technical Buyer

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Troutman, Cathy H.	Administrative Aide
Monteaperto, Camille	Telephone Operator

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Ables, Patricia E.	Administrative Aide
Matos, Carlos R.	Assistant Supervisor
Baez, Carlos	Driver
Chazen, Jonathan S.	Driver
Cocker, Edward J.	Driver
DeLoatch, Antonio P.	Driver
Mack, Maurice A.	Driver
Torres, Juan A.	Driver

TRAVEL

Bocsusis, Karen	Travel Reservationist
Kolacia, Paula M.	Travel Services Coordinator

1. Department of Earth and Environmental Sciences administrative staff. Clockwise from top left: Betty Hiscock, Administrative Aide, Mia Leo, Department Administrator, Carol Mountain, Financial Assistant, and Missy Pinckert, Administrative Aide.
2. Left to right: Bob Bookbinder, Manager of Computer Activities, and Doug Shearer, Senior Staff Associate.
3. Left to right: Mary Ann Brueckner, Library Specialist, Lisa Fish, Librarian, and Miriam Colwell, Library Assistant.

1.

2.

3.

"Doc" Ewing (at the wheel) and crew aboard the R/V *Vema*, the Observatory's first research vessel, circa 1954.

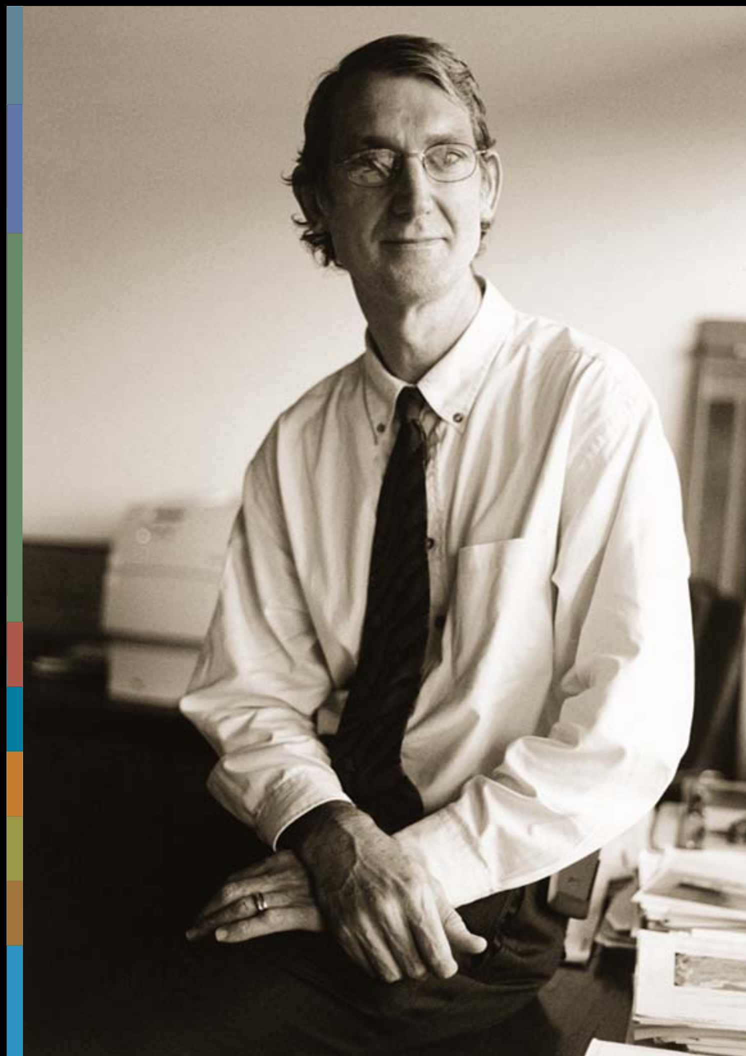
Letter from the Executive Deputy Director

When, late in 1948, Florence Corliss Lamont provided Torrey Cliffs, the Lamont family estate, to Columbia University in her husband's memory she could have been only vaguely aware of the nature of the person who would be the first leader of the Lamont Geological Observatory. The ink was barely dry on the documents of transmission before Maurice Ewing and a small group of colleagues decamped from Columbia's Morningside campus to the bucolic sanctuary of her former home. Ewing transformed the kitchen into a geochemistry lab, bedrooms into workspaces, and living areas into classrooms to create in a few short years one of the world's leading centers for research in the Earth sciences, more than fulfilling the hopes she had in giving the estate to her alma mater.

And Ewing quickly purchased a ship that became the R/V *Vema* on which he is seen in this photo (left) that must surely have been taken very shortly after the purchase. His legendary passion (perhaps obsession) to investigate the world's oceans resulted in this vessel being the first ever to sail one million miles in the service of science.

A passion for leadership in advancing our understanding of planet Earth has been the essential characteristic of Lamont's leaders ever since and is epitomized today by the current director, G. Michael Purdy.

Florence Lamont expressed a special desire in providing her estate to Columbia in her hope that "students from near and far would grow richer in wisdom from studying with the scholars of Torrey Cliff." As one who came as a student from afar and has had the privilege to serve in a leadership position at Lamont, I know that Florence Lamont and Maurice Ewing could look proudly on their Observatory as it sets sights on its second 50 years of achievement.



John Mutter
Executive Deputy Director

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