

# IN GALILEO'S WAKE

Say the word “ocean,” and most people think of waves breaking on a beach. But the place where surfers ride and ships sail is only the thin razor’s edge. “The ocean is actually a vast volume, 4 to 5 kilometers deep, that is our life support system on earth,” says John Delaney ’64, professor of oceanography at the University of Washington and lead researcher on the Ocean Observatories Initiative.

BY ELIZABETH SHIMER BOWERS

**D**elaney should know. He’s spent the past 40 or so years of his life diving into the ocean, literally and figuratively. Now, together with a team of scientists from several other institutions, he’s heading up a multi-faceted effort to study many aspects of the ocean through a combination of Internet-linked cables, and buoys connected to submerged data collection devices like seismometers, current meters, salinity probes, mobile robots bristling with sen-

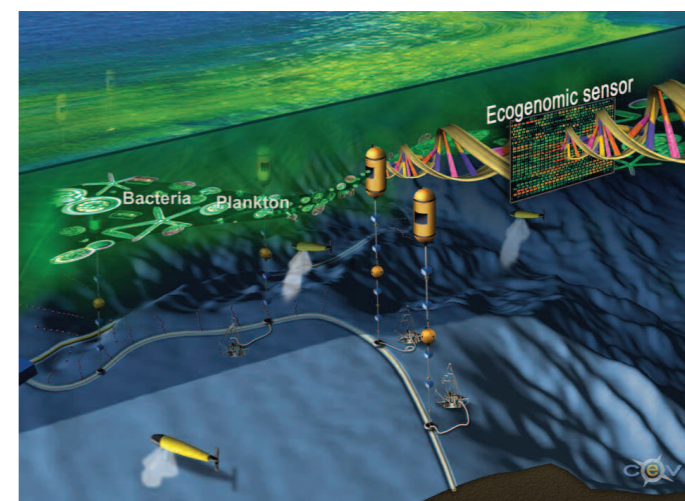
sors, and clusters of high-definition cameras. As he talks about the ocean—its effect on climate, the bizarre creatures that live there, and the new frontier of oceanic exploration on which he and his colleagues have embarked—Delaney’s true passion for his work is evident, both in the glimmer in his eye and in his eloquent descriptions of the endless applications of his work. This passion has translated into a groundbreaking research initiative slated to launch in

2010 that could change the way we view the ocean. The program, known as the Ocean Observatories Initiative, is slated to spend \$331 million in funding from the National Science Foundation (NSF) on construction of a novel and far-flung infrastructure that will use both wireless and wired communications to bring the oceans to laboratories, classrooms, and living rooms with access to the Internet. Delaney is no stranger to the NSF; the organization has been

funding his work on and off for the past 30 years, including his many dives to the sea floor using the research submarine Alvin. So, in a way, the NSF culture had a part in shaping his current focus. “This research began to emerge at first as a preoccupation, and then a fascination, and, eventually, a total passion,” Delaney says. “One of the things I do for a living is dive to the sea floor in a research submarine, and, when you do this, you realize that you can’t see much through the windows. After all, you are 2½ kilometers down and there is no daylight. “Plus, you might do 15 to 20 dives, one per day, on an expedition, but then it could be a year or two until you get back to the same location,” he says. “In that time, things can change rather dramatically if your research focus is on the evolution of submarine volcanoes.” Delaney realized there was

never going to be a way to truly understand the ocean by visiting a single area for 15 to 20 days every two years. “So that’s when I began thinking about how we could make ocean exploration better,” he says. “One of my colleagues told me about fiber optic cable, and we began talking about stringing a fiber optic cable with a power circuit from the shoreline all the

way out to the active volcanoes 250 kilometers off the coast of Washington and Oregon. And the more I talked to various people doing other oceanic research, the more I heard, ‘Well, if you are going to do that, then I could ... assess fish stock, track whales, monitor large earthquakes, study underwater avalanches. It became a movement.’

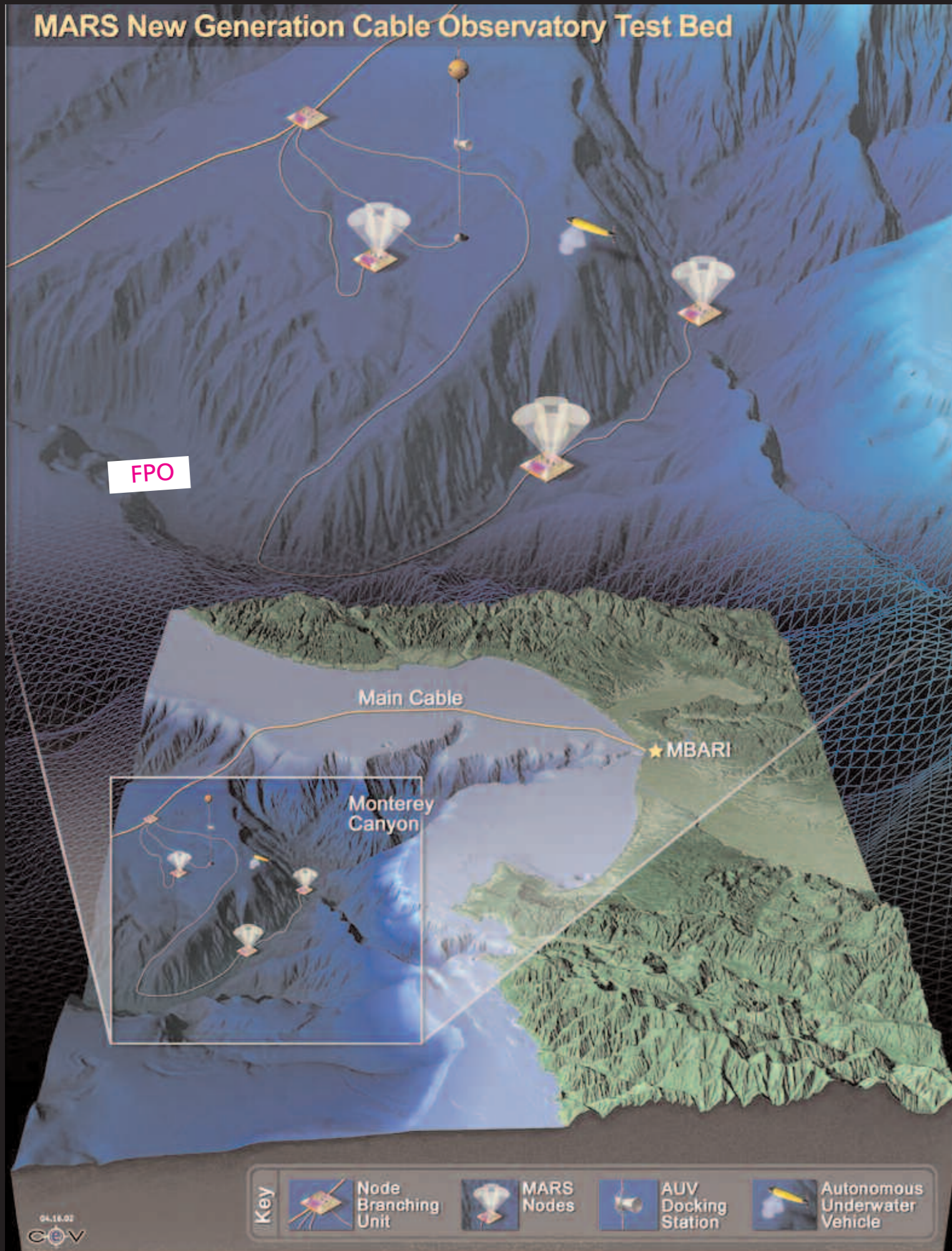


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— John Delaney

*Ecogenomic sensors will monitor some of the smallest ocean dwellers, including bacteria and other microbes. These sensors will collect DNA and protein information from the water to determine what microbes are present and how they respond to changes in their watery environment.*

## MARS New Generation Cable Observatory Test Bed



*Left: A prototype of the Regional Cabled Observatory was installed in the Monterey Bay. The Monterey Accelerated Research System (MARS) will allow scientists to test their equipment while collecting valuable research data.*

*Right: For the past 40 or so years, Delay has dived into the ocean's depths.*

*Bottom: Fiber optic cables will provide continuous power and high-bandwidth communication to underwater lights, high-definition cameras, robots, and chemistry and biology laboratories.*



## A SPACE CRAFT CALLED EARTH

In order to have live high-definition television on the sea floor beamed back to land in an interactive format—which is what Delaney and his colleagues have set out to achieve with the Regional Cabled Observatory—the bandwidth has to be very high. To do it in stereo with complex, real-time robotic manipulators within the volcanoes themselves, there must be considerable power as well.

“And electro-optical cables are the only way to achieve such a goal,” he says.

This sort of remote capability to both see and interact with something very far away in real time was first demonstrated on Sept. 7, 2001.

“A woman in France had her gallbladder removed by some doctors in the New York area,” Delaney says. “But September 11th happened, and you didn’t read about the operation much.

Nevertheless, it was a very significant development.”

Once Delaney discovered the potential of using electrical power and high-speed remote communications, he realized he didn’t need to be in a submarine 24 hours a day, 365 days a year to learn what he wanted to know about the ocean.

“There could be cameras and robots and communications, and it could all be displayed on land, in many locations simultaneously, with the potential for immediate, interactive feedback,” Delaney says.

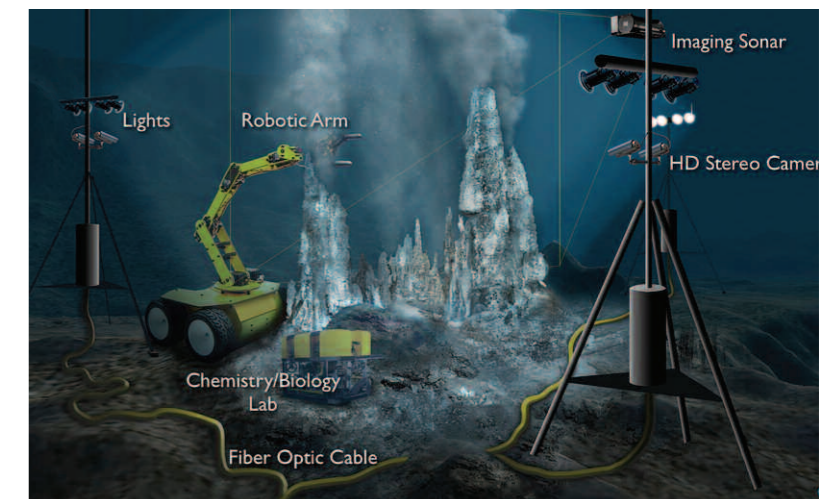
The displays that Delaney speaks of have several applications. For one, because all the information can be hard-wired into the Internet, anyone anywhere in the world will have the opportunity to view it on an Internet-linked com-

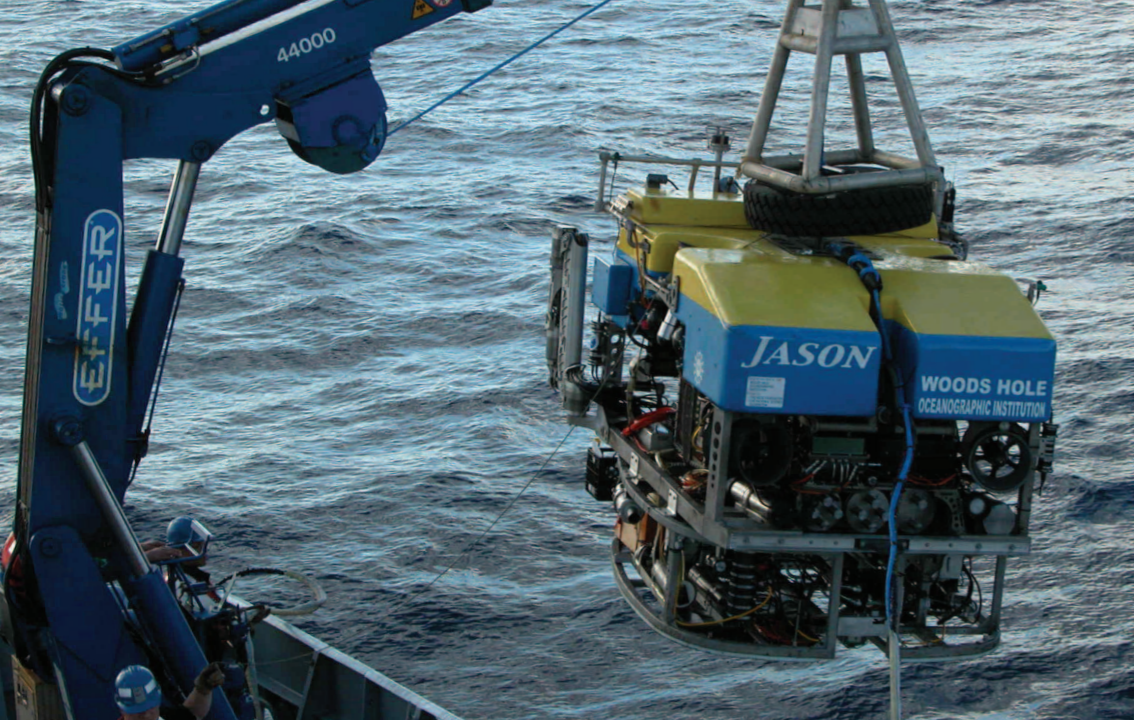
puter and use it for research.

“About two years ago, Bill Gates gave a talk about computing, and in his talk, he discussed how computers are changing how we do science, and how science benefits,” Delaney says. “He had 25 slides in his talk, and 11 of them were about the Regional Cabled Observatory—he used the project as an example of why we need very powerful computers and the sophisticated software-

middleware to operate these types of remote laboratories in the not-too-distant future.”

Because its capabilities are so far-reaching through the Internet, the Regional Cabled Observatory will be a wonderful tool for education, both of children and adults. Children will be able to learn more about the inter-workings of the ocean and the creatures that live there through live cameras and interactive games,





Left: The remotely operated vehicle Jason II is lowered into the water.

Right: Oceanography spans many interlocking disciplines, including meteorology, ocean dynamics, seismology, geology, fisheries, marine biology, botany, carbon cycle, hydrothermal vents, and earth and ocean processes.

while adults can log on for research purposes, education, weather information, or to simply satisfy their curiosity about the mysterious sea below.

“If you and your family and friends were going to go out of the solar system in a spacecraft, you would want to know everything you could about that craft—where it could fail, what its strengths were, what the energy sources were, how the pollution was handled, etc.

Well, it turns out you and your friends are on a spacecraft, and it’s called Earth; the global ocean is an integral part of the life-support system—and we have limited knowledge about how this complex system actually functions,” Delaney says.

For instance, if you were interested in a certain facet of oceanography, such as whale migration, you could log on to the Regional Cabled Observatory at [www.neptune.washington.edu](http://www.neptune.washington.edu) and see the whales right at that very moment, in real time.

“And you will be able to do the same with weather, underwater weather, underwater geology, underwater fish stock, etc.,”

Delaney says.

To demonstrate, he logs on to the Regional Cabled Observatory, where a sea creature resembling an octopus—what Delaney calls “a prime predator in the hydrothermal areas” that went undiscovered for centuries—dances around the darkness of the ocean floor.

He then clicks on a weather facet of the site, where one can instantly see the changes in ocean temperature mapped out over centuries.

## EDUCATION AS A TOOL FOR POLITICAL CHANGE

The Regional Cabled Observatory project has important political implications as well.

“People are now beginning to realize that climate change is one of the big issues,” Delaney says. “So taking these first steps to develop the capability to have routine observations and interactive human telepresence throughout any part of the ocean suddenly becomes a very crucial way

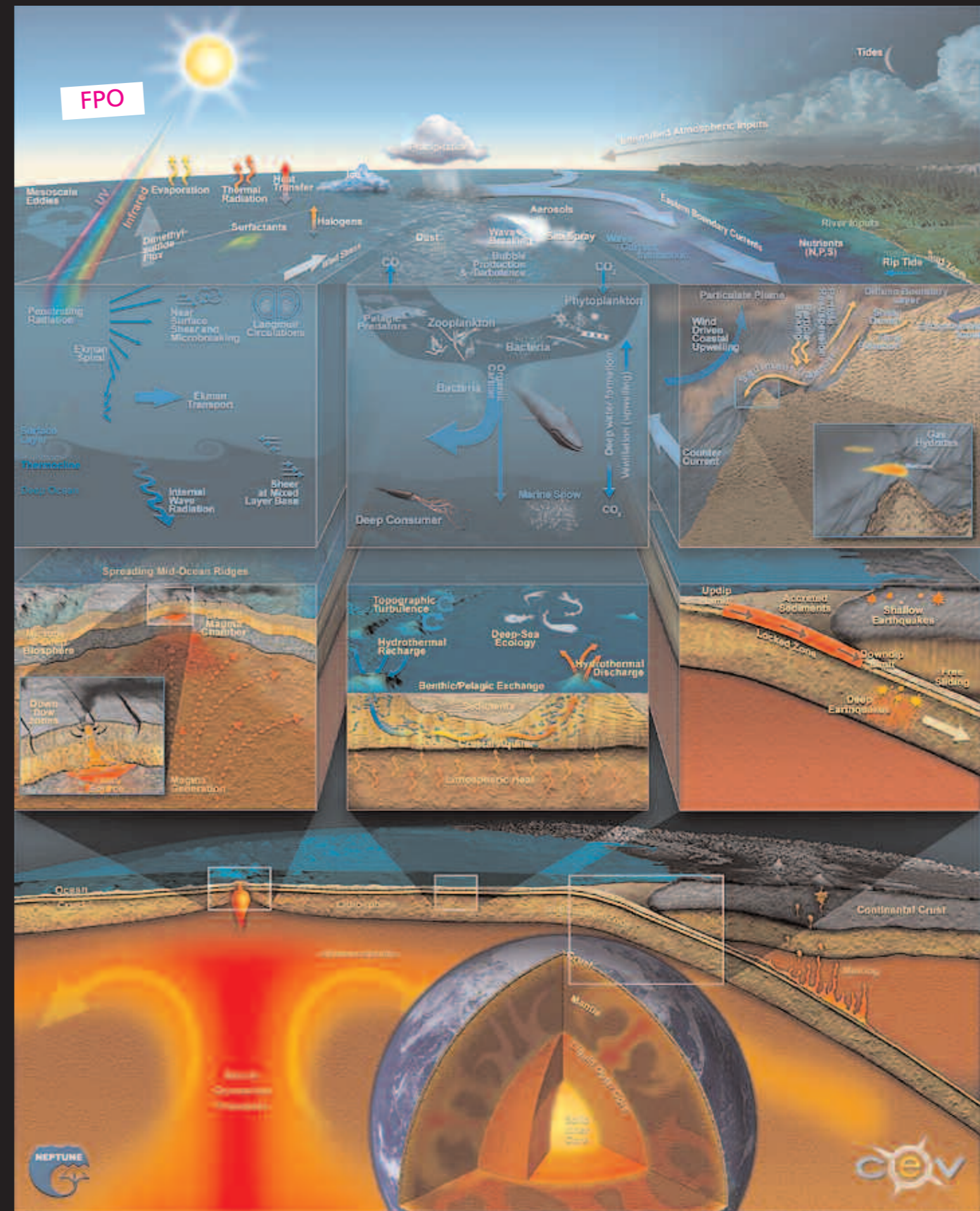
of constantly assessing global change.”

There is still debate over the extent and potential threat posed by climate change, and Delaney hopes having an unbiased suite of sensors and data that comes ashore and is available to everyone, everywhere, will contribute strongly to that dialogue.

“With this kind of facility, we will be able to say, unequivocally, ‘Here are the specifics of this oceanic information day in and day out, year in and year out, decade in and decade out,’ he says. “One of the most crucial things about the oceans is that as they change constantly, so change the weather patterns and the climate patterns; the drought, flooding, rainfall, and growth of vegetation on the continents—they are all tied to the rhythms of the ocean.”

Delaney hopes this oceanic awareness will make people realize the seriousness of our planet’s current state.

“Obviously, not everybody can or should be an expert on the ocean,” he says. “But taxpayers, voters, politicians, and journalists must realize that we do not live



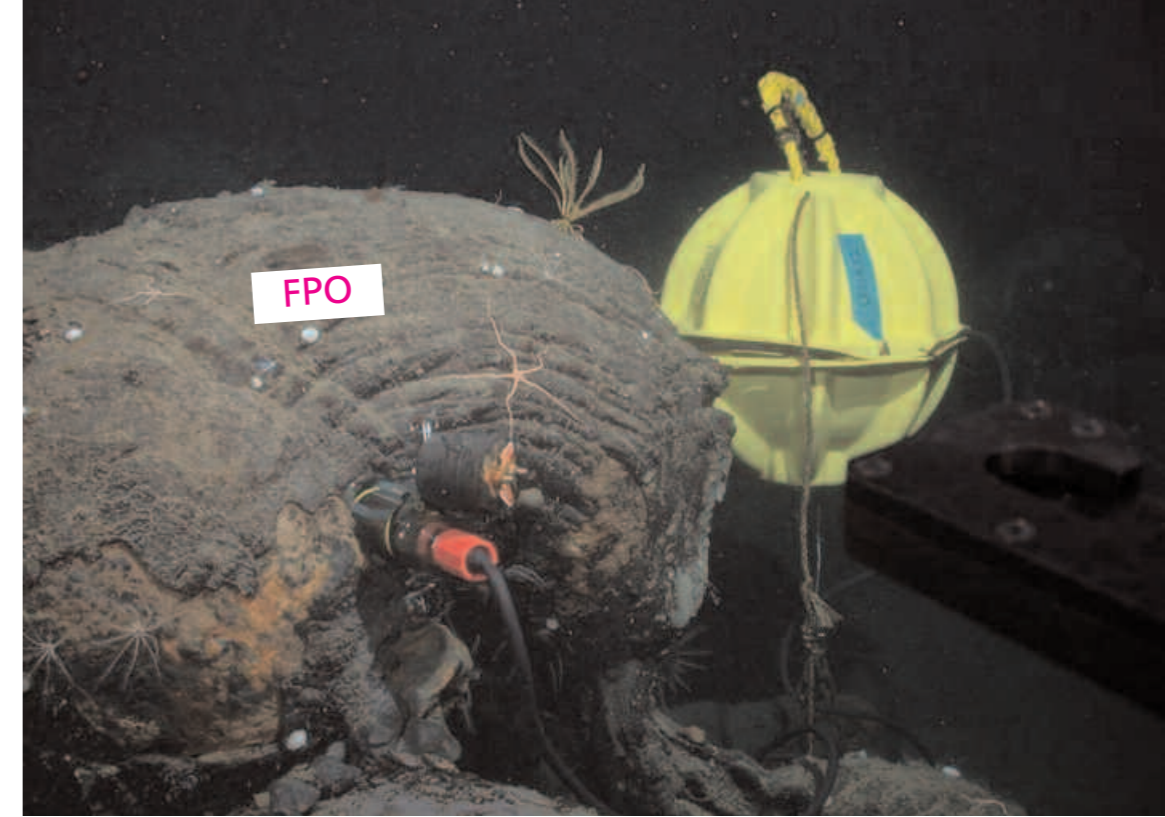
“Obviously, not everybody can or should be an expert on the ocean, but taxpayers, voters, politicians, and journalists must realize that we do not live on an inexhaustible system; it is increasingly obvious that the Earth system is finite, and we are pushing its limits.”

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*Left: Delaney, at sea, with several bright yellow seismometers stored behind him.*

*Right: A ocean-bottom seismometer records small, brief underwater earthquakes. The yellow “hardhat” encases a thick glass sphere filled with data loggers and batteries.*



on an inexhaustible system; it is increasingly obvious that the Earth system is finite, and we are pushing its limits. I believe that if people have expanding opportunities to learn, and growing incentives to understand our planet, they will demand more of their elected officials to preserve that crucial life-support system.”

He predicts that 20 years from now, there may be 15 more countries that have a system similar to the Regional Cabled

Observatory, and that 30 years from now, there may be 50 countries that have one of these systems off their coastlines. All will be linkable to a next-generation Internet so that there will be sophisticated distribution systems constantly providing information on the “health” of the ocean.

“At that point, we will probably have globally distributed sets of sensors with tens of thousands of instruments and observing capabilities, all of

which will be hardwired to a then-Internet and available to anyone who wants to evaluate what’s happening,” he says.

## A FOUNDATION BUILT AT LEHIGH

Before Delaney ventured to the ocean’s floor, he journeyed to the mountain—South Mountain, to be precise.

Delaney came to Lehigh University from Charlotte, N.C.,

to play basketball, and he majored in geology, a focus that laid the foundation for the rest of his career. After graduating from Lehigh, he earned his master’s degree in geology from the University of Virginia and his Ph.D. in geology from the University of Arizona.

“But the whole basis of my career as a geologist was fixed at Lehigh,” he says. “I learned the basic geology—mineralogy, the origin of volcanic rocks, thermo-

dynamics—all of those basic things that a geologist has to know, I learned at Lehigh. And not only that, at Lehigh, I got a lot of encouragement to be creative. I had many remarkable professors.”

One such professor was Larry Whitcomb, who taught geology.

“An older man, he was one of those prim and proper professors with a little mustache, always starting out with a tie,” Delaney recalls. “Then, in the lab, he would transform; his tie would be gone, his shirt tail would be out, his hair would be mussed, and he was talking about fossils—I found that fascinating.”

Delaney also recalls that in Whitcomb’s class—as well as in his other classes at Lehigh—students could ask many questions and receive thoughtful answers, an environment he has sought to re-create in his own classes at the University of Washington.

“I strive to be accessible to students and to encourage their creativity, but also to encourage

irreverence—a very delicate path for a professor,” says Delaney, who returned to Lehigh’s campus last fall for a reunion with former classmates. “I have always felt that the pursuit of truth is what is really important, not the defense of a position of authority.”

Overall, Delaney hopes to ignite the same passion for discovery in his students that he feels himself, to instill in them the excitement of the scientific adventure, or, as he puts it, “the commitment to figuring out how something works, the spark of enthusiasm for doing science in a fashion that makes you see something no one has ever seen before.”

The best way to make an incredible discovery is to work in an area where people haven’t worked a lot, which leads Delaney to Galileo, a man who—with a single unexpected observation—completely rewrote the position of human beings in the cosmos.

“If I have heroes, it is people who have made astonishing dis-

coveries and didn’t even intend to, the best example being Galileo,” he says.

Curiosity drew Galileo to explore the night sky and Jupiter’s moons. Today, a similar impulse drives Delaney to study the volcanoes on the ocean floor.

“We are on the threshold of learning things no one knew before, and that is incredibly exciting,” he says.

How much is left to be learned about the ocean? Delaney says it may be unbounded.

“There is not much known about what is yet to be discovered,” he says. “In the oceans, there are multiple frontiers: We have not explored all of the ocean, and because it is constantly changing, we are also exploring the time domain.

But if life as we know it exists beyond Earth, it will most likely be on planets with oceans and volcanoes, so understanding the evolution of our own system is a step toward an even more profound discovery—whether or not we are alone.”

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