

ocean matters

Newsletter: Rutgers Institute of Marine and Coastal Sciences

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IMCS Reveals New Methane Pits

Newly discovered at the bottom of the Hudson Canyon, the largest submarine canyon off the eastern United States, is a series of pits venting methane gas into the waters around the continental shelf. These vast methane deposits may help to explain why the area is such a fishing hotspot, says Peter Rona, an IMCS scientist and a leader, with Vincent Guida of the NOAA Northeast Fisheries Science Center, of the research cruise that discovered the methane pits about 100 miles southeast of New York Harbor.

The pits may also have implications in alternative energy and global warming, continues Rona, who likens methane to “a double-edged sword.” Produced primarily by microbial decay of organic matter, undersea methane is trapped in ice as gas hydrates within sediments that underlie the seafloor. “One estimate considers that more than half the organic carbon on Earth is trapped in gas hydrates, more than that in conventional oil and gas combined,” he explains. “Methane is thus a potential energy resource; at the same time, it is a potent greenhouse gas that contributes to global warming.”

Rona and his colleagues discovered the pits this past August during a research cruise aboard the NOAA vessel *Henry Bigelow*. Water samples recovered from the canyon revealed abnormally high levels of methane, while sonar data collected by the free-swimming underwater vehicle *Eagle Ray* (above) allowed scientists to map the contours of the pits that were venting the methane.

A wild card in global warming: potential energy source and potent greenhouse gas

says Rona, although they are a global phenomenon along sediment-covered continental margins and in Arctic tundra. The Hudson Canyon supports an abundant and diverse marine ecosystem, including an important fishery. This richness is likely fertilized by methane, a chemical energy source for bacteria and a nutritional boost that reaches all the way up the food chain. Methane, he points out, therefore helps to sustain commercial fish stocks on the adjacent continental shelf.

“As to methane as a potential energy resource, multinational oil companies and energy-related government agencies are experimenting to determine whether methane can be (continued on page 3)



Photo: Peter A. Rona

Coastal Ocean Observation Catches the Next Wave

Under development off the coast of New Jersey is a network of bright-yellow buoys, customized by IMCS scientists to carry sophisticated ocean observation technology. For now, the self-powered buoys, which convert wave energy into electricity, are attracting interest for their usefulness in at-sea surveillance and communications. One day, however, they may be celebrated as a new source of alternative energy: wave power.

The New Jersey-based company that makes the PowerBuoy® wave energy-conversion system, Ocean Power Technologies (OPT), turned to IMCS for its expertise in CODAR. “This high-frequency radar system provides near-real-time data on the speed and direction of the coastal ocean’s surface currents,” explains Hugh Roarty, research project manager at the Coastal Ocean Observation Lab (COOL). Such information collection is enhanced with the use of the wave-powered buoy system, a “smart” technology that is capable of responding to differing wave conditions.

At the same time, the buoy network improves the reach and strength of CODAR. With radar transmitters now deployed on the offshore buoys, as (continued on page 3)



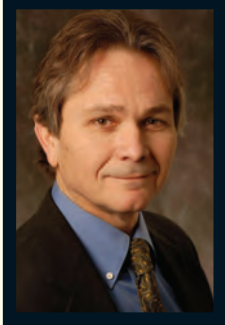
Photo: Dan Crowell

Milestone in Ocean Exploration

The first-ever ocean crossing by an underwater glider was hailed on both sides of the Atlantic, from the White House to the Spanish port town of Baiona, where an international delegation reclaimed IMCS’s own *Scarlet Knight* after 221 days at sea. To learn more about the historic journey and the role of gliders in climate research, **look inside.** →



“Partnering with IMCS, a world leader in coastal ocean observation, gives OPT a significant opportunity to enhance our PowerBuoy® wave-energy technology. Our collaboration brings to the marketplace an innovative New Jersey product offering.” —Charles F. Dunleavy (RBS’74), CEO, Ocean Power Technologies



Climate and Energy: IMCS Delivers Knowledge and Solutions

The Earth system is exhibiting accelerated environmental change, particularly along coastal zones—such as our own here in New Jersey—where the most densely urbanized regions are located. These changes have the potential to destabilize national and international social, economic, and political systems, presenting unprecedented challenges in human health, national security, and food production. Addressing these urgencies requires a new balance of fundamental scientific discovery, explicit consideration of human activities, and sustainable solutions achieved through partnerships among academia, business, and government.

As a world-class oceanographic research institute, IMCS is uniquely positioned to elucidate the role of ocean ecosystems in this changing global environment. And our geographic location gives us access to natural laboratories—from Barnegat Bay to New York Harbor, from the New Jersey coastline to the northwest Atlantic continental shelf—for studying the relationships among marine and coastal ecosystems and densely populated human environments. This research will lead to effective mitigation strategies and management practices that can be applied, worldwide, to areas similarly affected by urgent environmental problems.

This issue of *Ocean Matters* focuses on a range of research at IMCS targeting climate change and alternative energy. This research encompasses both the pursuit of scientific understanding (for example, identifying the cause of a mysterious phytoplankton die-off) and its application to practical strategies (for example, using genetics to improve algae's promise as a biofuel). At the heart of our work, whether discovering new knowledge or creating innovative solutions, is our deep respect for the oceans and the diversity of life that depends on them.

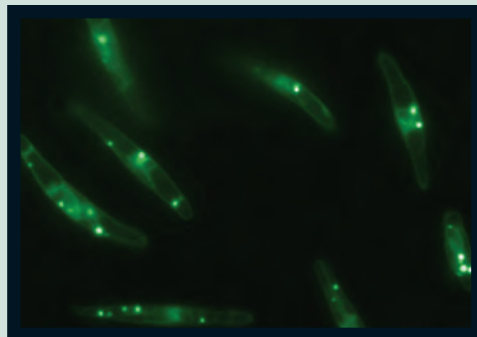
Energy from Algae? Genetics Could Be the Key

Wind, solar . . . algae? That's right, this single-celled phytoplankton is poised to join the portfolio of renewable-energy sources that could eventually replace fossil fuels. First, though, science has to overcome a few hurdles. An IMCS research team is focused on a key one: understanding exactly how algae produce the cellular oils, or lipids, that can be converted into transportation fuels.

Algae's star has risen as the limitations of ethanol and other crop-based biofuels have become clear, explains Paul Falkowski, the project's principal investigator and the director of the Rutgers Energy Institute (REI). Growing crops for fuel disrupts the global food supply, degrades ecosystems, and produces a net *increase* in dangerous greenhouse gases. Not so with algae, says Falkowski, adding, "Algal energy farms can be developed virtually anywhere with sufficient sunlight to allow sustainable harvests year round."

But algae won't become a commercially viable energy source until its lipid output can be maximized. That's where microbiologists SangHoon Lee, a visiting scholar, and Miguel Frada, a postdoctoral associate, come in. They are working in Falkowski's lab to unravel the processes behind lipid production in a specific marine alga, *Phaeodactylum tricornutum*.

Algae produce more—or fewer—lipids in response to various stressors. By exposing *P. tricornutum* to these known conditions, Lee and Frada can obtain a



Green stain reveals lipids within these algae cells.

table of total expressed genes associated with the up-regulation or down-regulation of lipid synthesis. Once the table is in hand, the pair can selectively suppress or enhance individual genes or combinations of genes to stimulate lipid production and accumulation in the alga.

It's a painstaking process and could take two to three years. But once the team's work is complete, scientists should be able to manipulate many different strains of algae so as to enhance their lipid-producing powers. This is critically important if algal biofuels are to be produced on a massive, economically feasible scale.

The research, sponsored by an individual with an interest in alternative energy, is a collaborative effort among IMCS, REI, and Rutgers' Waksman Institute of Microbiology.

BIG NUMBER



It's a first for science: a continuous deep-ocean temperature record stretching back 3.2 million years and providing new insights on climate change. By studying fossil shells from the deep-ocean floor, IMCS professor Yair Rosenthal and his graduate student, Sindia Sosdian, now of Australian National University, were able to construct a temperature record confirming that ocean cooling is associated with longer, more intense ice ages—previously a point of scientific contention. Scientists seeking to understand climate change, the IMCS study suggests, need to consider changes in ice sheets as well as greenhouse gases.

IMCS is a test bed for new technologies to track fish and monitor their critical habitats. Scientists are following the migrations of the Delaware River's shortnosed sturgeon, which is an endangered species, using an innovative combination of robotic submersible vehicles, sonar imaging, and remote sensing.

Atlantic Crossing Ushers in New Era for Ocean Research

When pulled from the choppy waters off the coast of Spain this past December, the *Scarlet Knight* was encrusted with barnacles but otherwise unscathed by her harrowing voyage. The underwater robotic glider had traveled 4,604 miles across the Atlantic Ocean, a seven-month journey piloted by the students and scientists who monitored her every move from the Coastal Ocean Observation Lab (COOL) at IMCS.

The glider's flight was a remarkable technological accomplishment: history's first ocean crossing by an unmanned vehicle. But it was also a major milestone in ocean exploration, "a seminal event," in the words of Richard Spinrad, the NOAA administrator who had issued the trans-Atlantic challenge three years before. The possibility that fleets of robotic gliders might roam the oceans, answering critical scientific questions, can no longer be considered the stuff of science fiction.

"Crossing the Atlantic proved that gliders can be piloted and sent on data-retrieving missions anywhere they are needed," says Scott Glenn, director of COOL and principal investigator on the project. In fact, during its transoceanic voyage, the *Scarlet Knight* collected data that is already contributing to more-accurate ocean and climate models. A world leader in glider exploration, the IMCS team has launched more than 165 glider flights, from Australia to Antarctica.

Glideres represent a significant improvement over conventional means of data collection, Glenn points out. Buoys are stationary; satellites read only surface conditions; ship-based research cruises are costly and complicated. But the torpedo-like glider, piloted remotely by scientists in a computerized control lab, can go wherever she is asked to go, nimbly and efficiently, no matter how distant or inhospitable the waters.

Outfitted with data sensors, gliders gather information on the oceans' temperature, salinity, acidity, and more. Because these



Rutgers undergraduates and international students from the Azores and Canary Islands piloted the glider mission from the COOL lab at IMCS.

variables are all affected by atmospheric conditions and the accumulation of greenhouse gases, they are critical to assessing the health of our oceans and understanding the nature of global climate change. The knowledge gleaned from glider missions can lead to better-informed policies to protect marine environments and confront the challenges of a changing climate.

This new frontier in oceanography is already being traversed. Routine ocean observations are now being made with gliders, while researchers are focused on creating a new generation that can rove farther and deeper on less power. And the IMCS team has picked up the next gauntlet: circumnavigating the globe with a glider.

New Methane Pits Discovered

(continued from page 1)

economically recovered," continued Rona. At the same time, "methane is a wild card in global warming, with major questions as to how much methane venting from the seafloor is assimilated by microbes and how much reaches the atmosphere as a greenhouse gas." This issue is a focus of ongoing research.

The Hudson Canyon research group included scientists from IMCS, the NOAA Northeast Fisheries Science Center, Stony Brook University, and the NOAA National Institute for Science and Technology at the University of Mississippi.

CODAR Rides the Waves

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well as on standard, one-way, land-based transmission towers, the CODAR system achieves a greater range and delivers a more reliable data stream. Quick to recognize the value of the CODAR-enhanced buoy network are the U.S. Coast Guard and the U.S. Navy, which are exploring its use in search-and-rescue operations and maritime surveillance.

As ocean scientists, the COOL team members envision myriad applications for the network, including the monitoring of

oil spills, algal blooms, ocean conditions, and coastal degradation, among other uses. And, as PowerBuoy® technology advances with the help of IMCS, New Jerseyans may look forward to a day when homes and businesses are powered with clean, renewable, environmentally safe electricity harnessed from the ocean.

"This is a win-win partnership for New Jersey, bringing together industry and academia to support new jobs and innovative technology within the state," says Scott Glenn, director of COOL.

The Atlantic Crossing "is a truly remarkable technological accomplishment, and, more importantly, it opens the door to improved forecasts of changes in the ocean and coast. Accurate data is so important as the world addresses the challenge of climate change and as we work to protect . . . the health of our environment."—Gary Locke, U.S. Secretary of Commerce



Sudden Death: Explaining Mass Die-Offs of Phytoplankton

What causes the sudden and mysterious death of phytoplankton—a major player in the global carbon cycle—in the North Atlantic Ocean? Scientists at IMCS have identified the culprit: a fatty compound within a virus that attacks and kills one of the world’s most-common phytoplankton, *Emiliania huxleyi*.

This ocean-drifting, plantlike organism is the “rock star” of marine phytoplankton, say marine biologists Kay Bidle, Assaf Vardi, and Liti Haramaty, blooming in masses so large they are easily detectable via Earth-observing satellites. As a member of the class coccolithophores, *E. huxleyi* produces calcium carbonate and has a large appetite for carbon dioxide; thus, the single-celled phytoplankton helps to regulate atmospheric levels of this greenhouse gas.

The blooms appear within days, and just as quickly vanish, victims of a virus that routinely infects natural populations and induces programmed cell death (PCD), a kind of cellular suicide. PCD, or apoptosis, is an essential pathway in biology, playing a critical role in the life and death of all cells—including human cells.

Working with a team from the Woods Hole Oceanographic Institution, Bidle’s group pinpointed the exact trigger setting off PCD in *E. huxleyi*: a viral fat molecule, or viral glycosphingolipid, previously unknown to science. The discovery has implications for research on climate change, as mass die-offs of phytoplankton can disrupt the global carbon cycle.

In addition, the findings have a real potential to advance cancer research. Cancer cells, unlike normal cells, have learned to deactivate the PCD pathway and become “immortal.” Bidle and his colleagues are currently investigating whether this viral glycosphingolipid induces apoptosis in cancer cells, thereby restoring their ability to die.

The team’s research was published in the November 6, 2009, issue of *Science*.



Photo: Jacques Descloitres/NASA

This satellite image shows a massive phytoplankton bloom in the Barents Sea north of Norway. Phytoplankton are “first responders” to climate change and thus serve as a bellwether for the health of the oceans.

IMCS ranks among the nation’s top 15 institutions in funding from the National Science Foundation for ocean science.

UPCOMING

Rutgers Day
April 24, 2010
10 a.m. – 4 p.m.

Celebrate IMCS at Rutgers Day. We’re marking 20 years—and counting!—of achievement with talks, tours, and open labs at the IMCS building on the Cook Campus. Explore all the fun and informative Rutgers Day events, including these from IMCS:

- Ocean Science for Kids
- Glider Demonstration in Passion Puddle
- Jersey Shore Touch Tank
- Movie Screening: *Volcanoes of the Deep Sea*
- and more!

More info: rutgersday.rutgers.edu

Study by the Sea
Alumni College 2010
June 4 – 6, 2010

Explore New Jersey’s beaches, bays, and backwaters with IMCS scientists while enjoying a weekend getaway at the Seaview Resort & Spa in Galloway. The educational program includes lectures, field trips, and outdoor adventure.

More info:
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