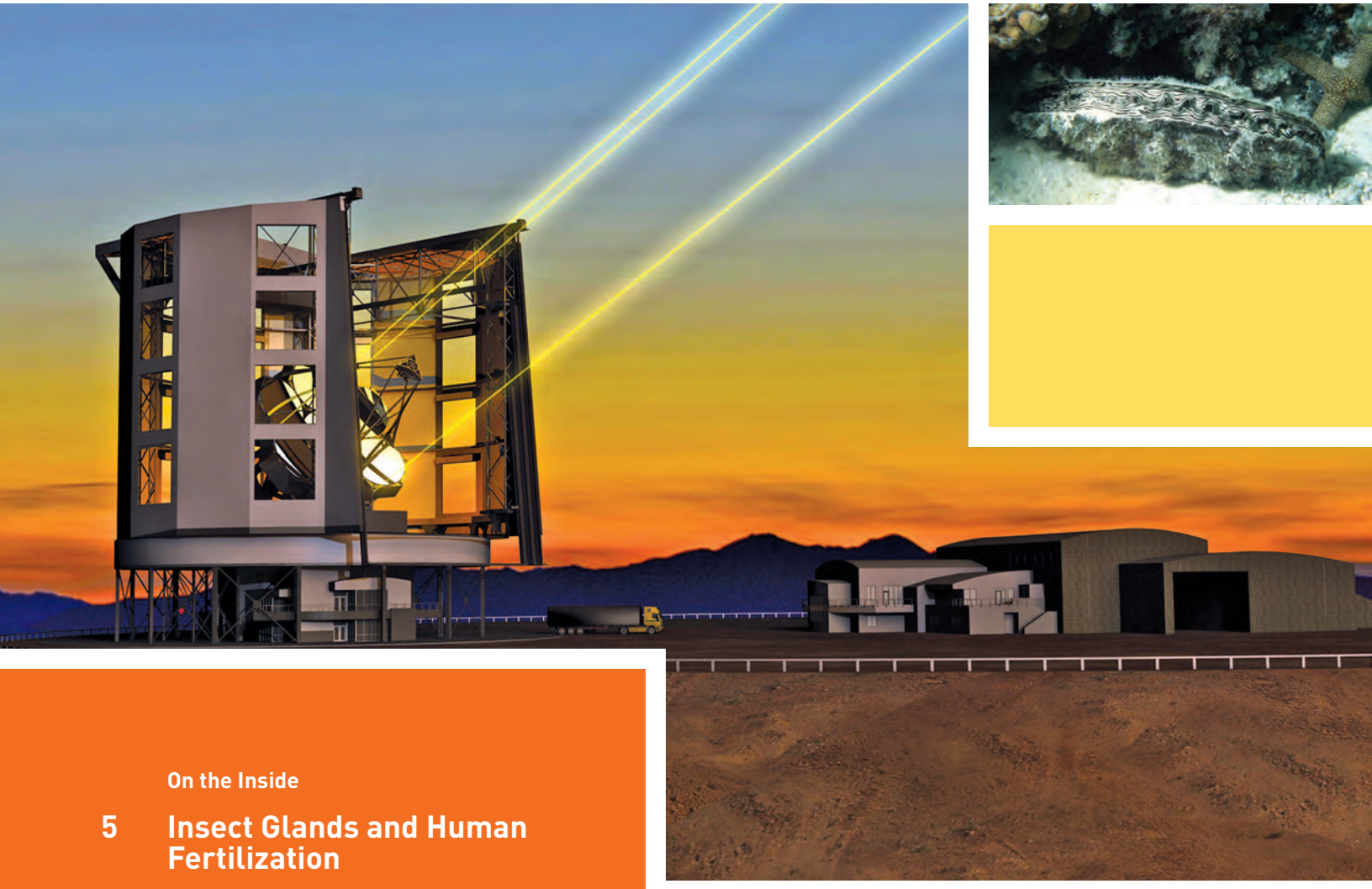
CarnegieScience

The Newsletter of the Carnegie Institution

SUMMER 2012

EMBRYOLOGY □ GEOPHYSICAL LABORATORY □ GLOBAL ECOLOGY □ THE OBSERVATORIES □
PLANT BIOLOGY □ TERRESTRIAL MAGNETISM □ CASE: CARNEGIE ACADEMY FOR SCIENCE EDUCATION



On the Inside

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LETTER FROM THE PRESIDENT

Communicating Science

As many have noted, the United States has serious deficits in K-12 education in science and mathematics. In 2009, the Programme for International Student Assessment of the Organization for Economic Cooperation and Development ranked the knowledge of science and mathematics of 15-year-olds in 75 countries. The U.S. ranked 31st in mathematics and 23rd in science, behind Estonia and Slovenia. Despite an effort to reinvigorate our educational system, the National Assessment of Educational Progress showed only a slight improvement in the scientific knowledge of U.S. students in 2011.

This is a problem with important implications for our economy and our future. But what can we do? There are a variety of approaches, but underlying all of them is the need to communicate the wonders of scientific discovery in engaging and exciting terms.

A number of our scientists communicate with the general public in this way. Climate scientists Chris Field, Ken Caldeira, and Greg Asner are regularly interviewed by the popular media about climate change and tropical forests. Planet hunter Paul Butler and astrophysicist Alan Boss have become media favorites for stories about extrasolar planets. Astronomer Wendy Freedman and planetary geophysicist Sean Solomon are go-to researchers about next-generation telescopes and terrestrial planets, respectively. And there are many others.

Communicating about science effectively involves more. A number of our researchers spread the word through teaching. The Carnegie Academy for Science Education, founded by President Emerita Maxine Singer in 1989, has touched thousands of teachers and students with the joys of hands-on science. More recently, she became the driving force behind the Washington, D.C., branch of Math *for* America, which seeks to improve mathematics teaching in D.C. schools. Biologist Marnie Halpern developed a science outreach program called Women Serious about Science in Baltimore, which provides female role models in science and engineering for girls. Her colleague, Steve Farber, is cofounder of BioEYES, which has trained over 50 teachers and 6,000 students in the Baltimore region in the study of genetics, developmental biology, and even water quality through the use of zebrafish. Plant biologist Kathryn Barton conducts a class at Stanford on hunger, which ranges from neurophysiology to world food security.

Mineralogist Bob Hazen not only teaches at George Mason University but also lectures worldwide on subjects ranging from the origins of life to the cycling of carbon deep within the Earth. And recently, a number of our researchers manned the Carnegie Science booth at the 2nd USA Science and Engineering Festival, in Washington, D.C. It is the largest expo celebrating science in the United States.

I applaud all these efforts by Carnegie staff to engage the public with the excitement of science. As these researchers and others have found, the key to effective communication is the use of plain language, compelling imagery, and revealing analogies—characteristics that we hope the articles in this newsletter exhibit. Perhaps most important, however, is the need to exhibit genuine enthusiasm. If we are to achieve literacy in science and mathematics, we need to entice a new generation to appreciate the excitement of scientific discovery. All of us should see this task as a fundamental obligation.

Richard A. Meserve, *President*

The president and the chairman of the board alternate roles in presenting an introductory letter.

New & Returning Board Members

The board of trustees gathered at the administration building in Washington, D.C., on May 3 and 4. The Nominating, Employee Affairs, Finance, and Development committees met Thursday the 3rd, followed by the first session of the board, while the Audit Committee and the second session convened on the 4th. Two new board members were unanimously elected—Michael Long and Cristián Samper. Michael Duffy also rejoined the board.

Michael Long

Michael Long is co-founder and president of Premier Wireless, Inc., based in Anaheim, California. The company provides wireless audio and video equipment for industrial, commercial, and broadcast use. Prior to that, Long was president of Dynatech Spectrum, a manufacturer of wireless video transmitters, mostly for the personal security market. Earlier, he was vice president of engineering at Dynatech Microwave Technology and president and CEO of American Microwave Technology. Long received his A.B. in physics from the University of Chicago and completed graduate work at UCLA and Stanford University.

Michael Long was unanimously elected to the Carnegie board.

Cristián Samper

As of August 1, Samper will become president and CEO of the Wildlife Conservation Society in New York City. He has been the director of the Smithsonian's National Museum of Natural History, where he renovated major exhibitions and collection facilities, developed new digital outreach endeavors, created a succession plan for researchers and a training program for younger scientists, cofounded the Encyclopedia of Life, and raised more than $150 million in gifts. A Colombian native, Samper served as the director of the environment division of the Foundation of Higher Education in Colombia in the early 1990s. He earned a B.S. in biology from the Universidad de Los Andes in Bogotá and his master's and doctorate in biology from Harvard University.

Cristián Samper was unanimously elected to the Carnegie board.
Image courtesy Smithsonian Institution

Michael Duffy

Michael Duffy joined the Carnegie board in 2007. He became a senior trustee in 2010 and has now rejoined as a full member. Duffy is a founding partner at Strategic Investment Group in Arlington, Virginia. The firm manages customized portfolios for institutional and private investors. Duffy directs research on global asset allocation modeling, and analyzes equity strategies and the economic environment and its impact on investment policy. Duffy was also a founder of Emerging Markets Management and was its treasurer and a managing director. Earlier in his career he was a senior pension investment officer at the World Bank and an economist with the Board of Governors of the Federal Reserve Board in Washington, D.C. Duffy earned a B.A. in economics from the University of Michigan and both an M.A and a Ph.D. in economics from the University of Chicago.

Michael Duffy has rejoined the Carnegie board as a full member.

Harold Varmus Speaks at Annual Dinner

This year's speaker at the annual dinner was Nobel Laureate and director of the National Cancer Institute Harold Varmus. After giving an overview of cancer research, he focused on a new initiative at the Cancer Institute called Provocative Questions. This program was designed to find new, nonobvious ideas for cancer diagnosis and treatment in an environment of limited funding. Examples of new areas of research include understanding how chemotherapy cures cancer (which is not known), discovering the obesity-cancer link, unraveling why there are different rates of cancer in different locations around the world, understanding why some organs are more prone to cancer than others, and discovering why nerve-degenerating issues like Alzheimer's are associated with low rates of cancer. From 750 applications, the program will fund 40 to 50 grants. The hope of the program is to define more potentially game-changing scientific questions that could influence the directions taken by institute-sponsored research. More questions can be viewed at the link http://provocativequestions.nci.nih.gov/rfa. The evening concluded with a performance by Jack Ludwig, oboist, and Keiju Takehara, pianist, both students at the Levine School of Music. They performed an ensemble for oboe and piano by Robert Schumann. □

Nobel Laureate and director of the National Cancer Institute Harold Varmus talked to trustees, donors, and guests about a new program at the institute to stimulate game-changing cancer research.

Two Honored with

Service to Science Awards

Every year at Carnegie Evening, President Richard Meserve presents awards that recognize outstanding and/or unique contributions to science by employees who work in administration, support, and technical positions at Carnegie. Two recipients were named for 2011: Director of Administration and Finance until his retirement in 2011, Gary Kowalczwk, and Broad Branch Road librarian Shaun Hardy.

Former director of administration and finance Gary Kowalczyk was a recipient of the 2011 Service to Science Award.

Librarian Shaun Hardy, from the Broad Branch Road campus, received the 2011 Service to Science Award.

Gary Kowalczyk

Gary joined Carnegie in February 2006 and fundamentally rebuilt Carnegie's business operations. When he arrived, the business side was plagued with problems, in large part because they became more complex over time and because the requirements associated with federal funding had become far more complicated. Gary upgraded all of the business operations and, under his stewardship, the relationship between headquarters and the departments was markedly improved. He interacted extensively with the department directors, business managers, and scientific staff. He listened carefully and developed solutions that served both to reflect sound business management and to facilitate the departments' work.

Gary's legacy includes a highly professional and capable business staff, a modernized accounting system, extensive revision of Carnegie's policies and procedures, innovative intellectual property arrangements, and a revitalized usage of Carnegie's headquarters facility. Perhaps, most importantly, Gary was strongly supportive of the fundamental purpose of the institution—namely, the advancement of science. Through his intelligence, diligence, and skills, he contributed very significantly to Carnegie's continuing scientific strength.

Gary retired in October 2011, yet he continues to provide support and assistance to Carnegie on a consulting basis. The Carnegie Institution is fortunate to have Gary as one of the many dedicated persons who support its scientific mission. □

The awardees receive a citation and medal (shown above) for their support in advancing Carnegie science.

Shaun Hardy

Shaun Hardy joined Carnegie in 1989 and has been the head librarian at Broad Branch Road since 1990. Shaun's skills became apparent when he coordinated the merger of the Terrestrial Magnetism and Geophysical Laboratory libraries in 1990. Collections had to be trimmed while preserving core material for the breadth of science of the combined campuses. He created an exceptional and unique science library—a feat helped by his undergraduate degrees in geology and physics and a degree in library and information studies.

Shaun is interested in the science itself. One staff member said, "While I try to keep track of all of my own publications, I am amazed that Shaun often knows more about many of them than I do." Our scientists could not produce the science they do, or be as successful in grant writing as they are, without Shaun's constant expert support.

Shaun is particularly resourceful. When faced with the need to downsize the paper journal archive, he found a charitable firm that would pay for shipping bound volumes to institutions in developing countries. He organized volunteers to pack 700 boxes of bound journals and load them onto a truck for transport to Xiamen, China, freeing up hundreds of feet of shelf space.

In addition to foresight and exceptional organizational and management skills, Shaun has brought energy, enthusiasm, and professional knowledge to his work. He has helped enable state-of-the-art access to the information that is essential for Carnegie scientists to have continued leadership in their fields. The Carnegie Institution is fortunate to have Shaun as one of the many dedicated persons who support its scientific mission. □

Hunting the Heart of the Plant

When hunting down clues to how plants move sugars from the leaves where they are produced to their other organs, Wolf Frommer, director of the Department of Plant Biology, compared himself to the fictional character Miss Marple. Frommer discussed his research in his talk titled "How the Heart of the Plant Feeds the World" at May's Carnegie Evening lecture in Washington. He described the process as "trying to find the culprit, finding some circumstantial evidence to very simple questions."

Wolf Frommer delivers May's Carnegie Evening lecture in Washington, "How the Heart of the Plant Feeds the World."

Just as it's necessary for the human body to move nutrients to all of the organs, it is vital for green plants to transport sugars to supply its various parts. In humans, this is the circulatory system's job. But plants do not have a heart to move these vital energy sources. Instead, plants use a molecular pump to move sugar from their leaves into their veins.

"We were interested in understanding how this worked mechanistically," he told the crowd. Frommer described the process of his search for the components of this pump.

In the process of tracking down the pump components, Frommer and his lab developed new technology to help them. Most crucially, they created nanosensors known as Förster Resonance Energy Transfer, or FRET, biosensors, to report the flux of sugar in individual cells with a simple color change. This technology has a vast array of research uses, including the study of brain chemistry, cancer defenses, and biofuel development.

Frommer's long-term studies on the movement of sugars and the molecular pump are vital for understanding and improving agricultural yields. In a world where food prices are soaring and the Earth's population is nearing 9 billion, the need for increased crop yields is extremely important.

The identification of the role of these transporters in plant infections provides a new perspective on plant pathology and a totally new way of protecting plants from pathogens, further increasing crop yields and food security. "Food is related to keeping social stability," Frommer said. □

Insect Glands and Human Fertilization

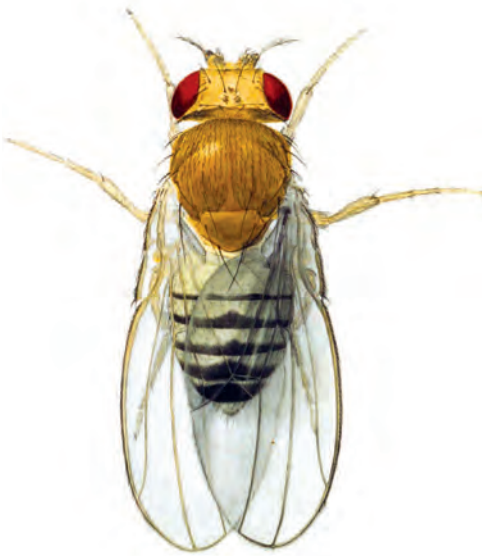
Insect glands produce a host of secretions allowing bees to sting and ants to mark trails to and from their nests. In a recent study Carnegie scientists Allan Spradling and Jianjun Sun focused on secretions from glands in the reproductive tract that help sperm survive and guide them to fertilize an egg. The gene that controls the development of these glands in fruit flies provides important information about gland development in all insects, as well as potential clues to similar human reproductive glands. Their work was published in May in *Current Biology*.

When a female fruit fly receives sperm from a male fruit fly, secretions in her reproductive tract activate the sperm, store it, and guide it to fertilization. Without these secretions, sperm would not make it to the eggs. The scientists demonstrated that the gene in charge of regulating the development of fruit fly secretion glands is called *Hr39*. It encodes a steroid receptor protein. Mutant fruit flies that lack this gene have no such glands and are infertile. However, their formation could be partially restored with the expression of a mouse gene that encodes an analogous steroid receptor in mammals called *Lrh-1*. Mutant mice that lack this gene are also infertile.

The work demonstrates that even though it has been millions of years since there was a common ancestor that links fruit flies to mice—and, more generally, insects to mammals—these similar genes are still in charge of at least some of the same functions.

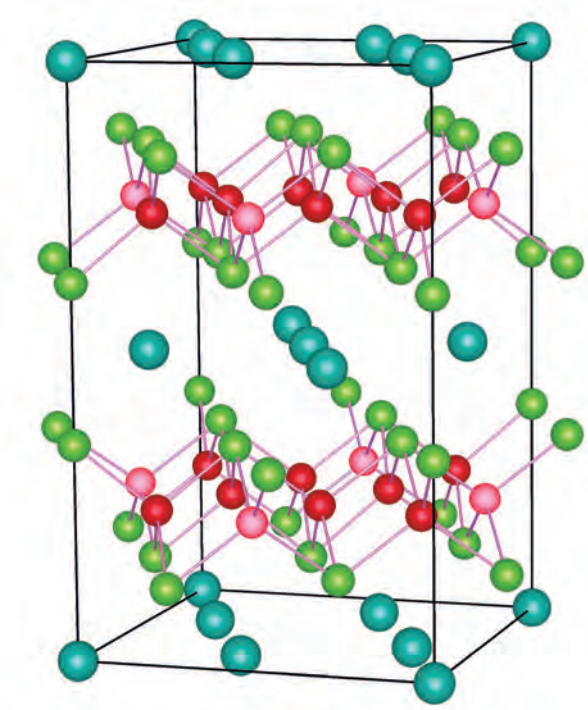
Secretions from reproductive glands in mammals are thought to assist sperm in undergoing similar changes to facilitate fertilization. But studying this process has proved difficult. Knowing that the functions of *Hr39* in fruit flies and *Lrh-1* in mammals are similar in this regard will facilitate research.

"The fruit fly work in our paper provides a method for studying the cellular physiology governing this reproductive secretion process more quickly, cheaply, and effectively than we had previously thought possible," Spradling remarked. □


Studies of reproductive secretions of the fruit fly *Drosophila melanogaster* may help in understanding fertilization in other organisms including humans.

Allan Spradling and Jianjun Sun are funded by the Howard Hughes Medical Institute.

Now You SEE IT | Now You DON'T



The image at left is an image of the crystal structure for the lower-pressure superconducting state.

The image below right shows the magnetic structure of the material. The + and - symbols indicate electron spin directions. At high pressures vacant sites will be filled with a diffused charge from a neighboring iron site. When the occupancies are equal, there is no magnetism and the material transforms.

Images courtesy Xiao-Jia Chen

SUPERCONDUCTIVITY is a rare physical state in which matter is able to conduct electricity—the flow of electrons—without any resistance. This phenomenon can only be found in certain materials at low temperatures, or it can be induced under chemical and high-pressure conditions. Research to create superconductors at higher temperatures has been ongoing for two decades, with the hope of improving electricity transmission. New work from a team including Carnegie's Xiao-Jia Chen and Ho-kwang "Dave" Mao found unexpected superconducting behavior in a type of compound called iron selenium chalcogenides. Their work was published online by *Nature* on February 22.

The electrical resistance of superconductors disappears at a critical transition temperature, T_C. The early conventional superconductors had to be cooled to extremely low temperatures—below T_C—for electricity to flow freely. In the 1980s, scientists discovered a class of relatively high-temperature superconductors and have continued to study this phenomenon in an array of materials. It has been established that superconductivity can be affected by a substance's crystallographic structure, electronic charge, or the orbit of its electrons.

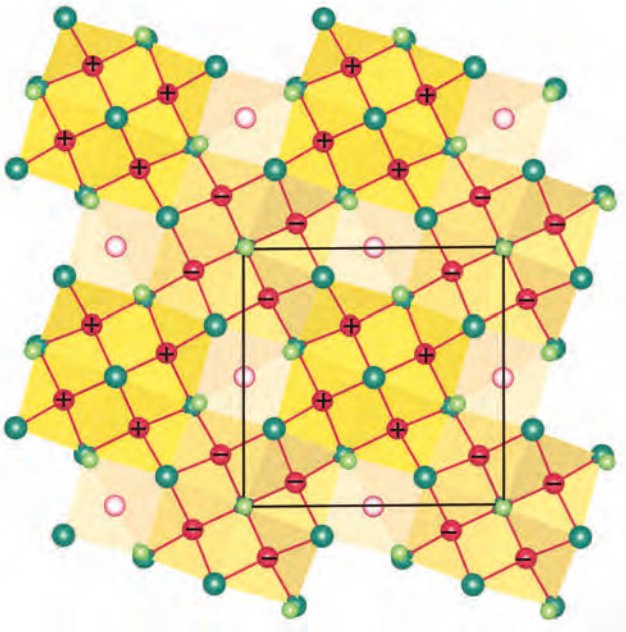
Recently scientists discovered superconductivity in iron-based selenium chalcogenides. Chalcogenides are compounds that combine an element from group 16 on the periodic table (including sulfur, selenium, tellurium) with another element, in this case iron. A selenide is a chemical compound containing selenium.

It was known that under pressure iron selenides become superconductors between -406°F and -402°F (30-32 K). But the research team, led equally by Liling Sun of the Chinese Academy of Sciences and Xiao-Jia Chen, discovered that a second wave of superconductivity can be observed at higher pressures.

Working on an iron-based selenide, the team observed a transition temperature that starts at -400°F (33 K) under about 16,000 times normal atmospheric pressure (1.6 Gigapascal or GPa) and shifts to lower temperatures as the pressure increases, until it vanishes at about 89,000 times atmospheric pressure (9 GPa). But then superconducting reappears at pressures with a transition temperature of about -373°F at around 122,000 times atmospheric pressure (12.4 GPa).

"These observations highlight the search of high-temperature superconductivity in complex structural and magnetic materials," Chen said. The researchers confirmed these results with a variety of magnetic and electrical-resistance measurements. They were also able to find reemerging superconductivity in another type of iron-based selenium chalcogenide, under very similar conditions.

The basic structure of these compounds was not changed under the extreme pressure, and thus further research is needed to determine what is happening on a closer structural level. Chen stated that "our work will likely stimulate a great deal of future study, both experimental and theoretical, to clarify what causes this reemergence of superconductivity." □



In China, this research was supported by the NSCF, 973 projects, and the Chinese Academy of Sciences. In the United States, it was supported by EFree, which is funded by the Department of Energy; the Carnegie Institution for Science; CDAC; UNLV; LLNL; and DOE.

Do Sea Cucumbers Dissolve Coral Reefs?

Numerous sea cucumber species populate Australia's Great Barrier Reef.
Image courtesy Dwayne Meadows, NOAA/NMFS/OPR

Normally teaming with life, coral reefs are now threatened. Carbon dioxide emissions are acidifying the ocean, endangering them and other marine organisms. In a new twist, research led by Global Ecology's Kenneth Schneider found that the dietary process of sea cucumbers, by dissolving calcium carbonate ($CaCO_3$) from the surrounding reef in areas of the Great Barrier Reef, accounts for about half of the total nighttime reef dissolution. The work was published in the December 23, 2011, issue of *The Journal of Geophysical Research.*

Reefs are formed through the biological deposits of calcium carbonate ($CaCO_3$). Many of the marine organisms living on and around a reef contribute to either its destruction or its construction. It is therefore crucial that the amount of calcium carbonate remain in balance. When this delicate balance is disrupted, the reef ceases to grow and its foundations can be weakened.

To fully understand a reef's ability to deposit carbonate and grow, it is necessary to understand the roles that the various elements of sea life play. This is especially important because increased atmospheric carbon dioxide is predicted to decrease the amount of carbonate available due to acidification. The research group set out to examine the role that sea cucumbers play in the reef environment.

Schneider's team included Carnegie's Ken Caldeira as well as Jacob Silverman, of the Israeli Limnology and Oceanography Institute; Maria Byrne and Erika Woolsey, both of the University of Sydney and the latter also from James Cook University; and Hampus Eriksson of Stockholm University.

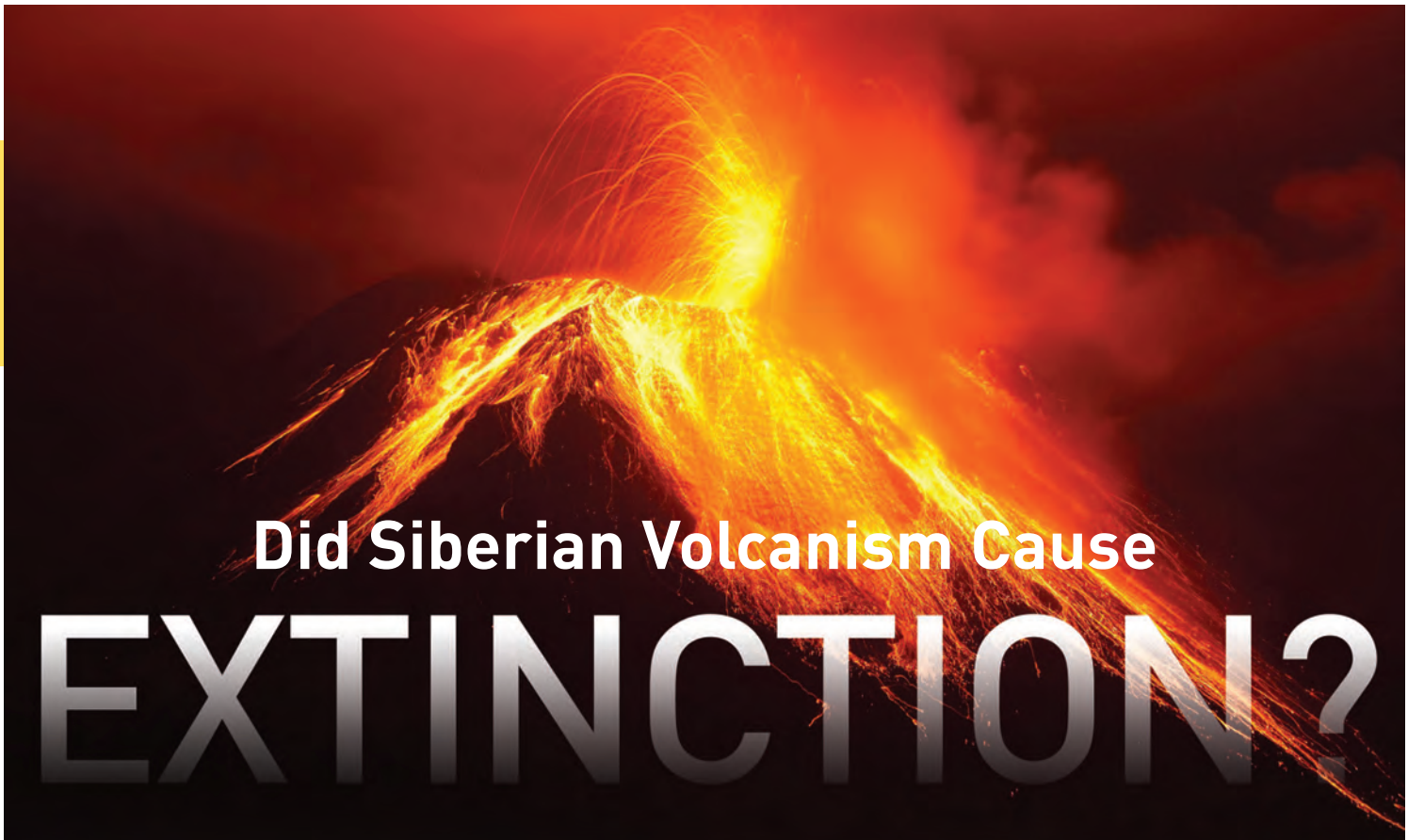
They studied the growth and dissolution of One Tree Reef, which surrounds One Tree Island in Australia's Great Barrier Reef. They found that sea cucumbers were abundant and collected some to study the effect on seawater resulting from the sand and rubble transported through their gut system as they digested.

As part of another ongoing study in this area, the team found that the coral reef was dissolving at night. They found that sea cucumbers play a crucial part in this process. They live off the bits of organic matter in the carbonate sand and rubble that they ingest. In this process, their digestive systems produce acids that dissolve parts of these carbonate minerals. The dissolved carbonate minerals are then released into the surrounding environment. The researchers found that these organisms might be responsible for half of this nighttime-released $CaCO_3$.

Burning coal, oil, and gas releases CO_2 into the atmosphere, which is later absorbed by the ocean, causing it to acidify. Ocean acidification is expected to slow reef growth. With slower reef growth, the dissolution of $CaCO_3$ within the guts of sea cucumbers is expected to become even more important to a reef's $CaCO_3$ budget.

"Even though the sea cucumbers dissolve $CaCO_3$ on the reef, in a lagoon such as the one at One Tree Reef, where there is limited seawater exchange with the surrounding ocean, they can be important in recycling of nutrients to support primary productivity. They also increase seawater buffer capacity to partially offset ocean acidification effects, helping to maintain the overall health of the coral reef," Schneider said. "Although sea cucumbers may play a part in reef dissolution, they are also an important part of an incredible marine environment." □

This research was supported by the Gordon and Betty Moore Foundation. The authors thank the University of Sydney's One Tree Island Research Station facility.



Did Siberian Volcanism Cause EXTINCTION?

Linda Elkins-Tanton

There was a cataclysm some 250 million years ago, at the end of the Permian geologic period. It was a mass extinction so severe that it remains the most traumatic known species die-off in Earth's history. Although the cause of this event is a mystery, it has been speculated that the eruption of a large swath of volcanic rock in Russia called the Siberian Traps was the trigger. New research by Carnegie's Linda Elkins-Tanton and her coauthors offers insight into how this volcanism could have contributed to drastic deterioration in the global environment. Their work was published January in *Earth and Planetary Science Letters*.

More than 90% of marine species and more than 70% of terrestrial species went extinct at the end of the Permian period. The fossil record suggests that ecological diversity did not fully recover until several million years later. Volcanic activity in the Siberian Traps has been proposed as one of the mechanisms that may have triggered the mass extinction. Gases released as a result of Siberian magmatism could have caused environmental damage. Atmospheric sulfur particles, for instance, could have reflected the Sun's heat back into space, cooling the planet; or maybe chlorine and other chemically similar nonmetal elements called halogens significantly damaged the ozone layer in the stratosphere.

The team designed experiments to examine these possibilities. Led by Benjamin Black of the Massachusetts Institute of Technology, the group included Elkins-Tanton, formerly of MIT and now director of Carnegie's Department of Terrestrial Magnetism, Michael C. Rowe of Washington State University, and Ingrid Ukstins Peate of the University of Iowa.

The geology of the Siberian Traps is comprised of flood basalts, which form when giant lava eruptions coat large swaths of land or ocean floor with basaltic lava. This lava hardens into rock formations. The team investigated concentrations of sulfur, chlorine, and fluorine that were dissolved in tiny samples of ancient magma found within the basalt. These small frozen droplets, called melt inclusions, preserve a record of volcanic gases from the time of the eruption 250 million years ago.

Sulfur, chlorine, and fluorine gases could have been released into the atmosphere from eruptions through large fissures, which is common in basalt flood formation. The escaping plumes could have reached the stratosphere. If sulfur, chlorine, and fluorine made it to the upper atmosphere, they could have caused a wide array of adverse climate events, including temperature change and acid rain.

Based on their findings, the team estimated that between 6,300 and 7,800 gigatons of sulfur, between 3,400 and 8,700 gigatons of chlorine, and between 7,100 and 13,700 gigatons of fluorine were released from magma in the Siberian Traps during the end of the Permian period. The group says more research on atmospheric chemistry and climate modeling is needed to determine whether these gases could have been responsible for the mass extinction. □

Funding for this research was provided by NSF's Continental Dynamics program, the MIT Wade Fund, and University of Iowa start-up funds. Some samples were provided by the American Museum of Natural History

Endangered Madagascar Gets Help

1 The Madagascar team worked in many different areas including rugged hill country.

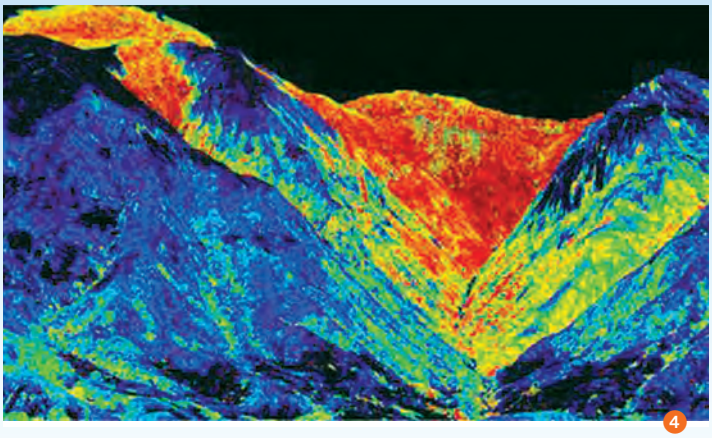
2 The Madagascar team included researchers, technicians, and locals. Team leader Greg Asner is second from right in the back row.

3 Global Ecology's Robin Martin collects samples.

4 This 3-D map shows a valley and remaining mountainous forests. Reds indicate relatively intact canopy that contain higher carbon levels. Yellows and greens reveal degraded forests, while black and blues show deforested areas.

5 Human activity has led to widespread degradation in Madagascar.

Images courtesy Greg Asner lab



The rugged, remote island of Madagascar has unique flora and fauna found nowhere else on Earth, but habitat destruction has transformed its tropical forests, leaving a patchwork of different landscapes. The terrain makes it very difficult to measure vegetation carbon content via traditional plot sample methods. Plots alone are impracticable for establishing carbon content for large and diverse areas and often do not account for the great degree of landscape variability.

Global Ecology's Greg Asner and team are combining airborne laser technology, satellite mapping, and ground-based plot surveys to produce the first large-scale, high-resolution estimates of carbon stocks in fragile Madagascar. The group has shown that it is possible to map carbon stocks in rugged geographic regions and that this type of carbon monitoring can be successfully employed to support conservation and climate-change mitigation under the United Nations initiative on Reduced Emissions from Deforestation and Degradation (REDD).

The team includes scientists from Carnegie's Department of Global Ecology, the GoodPlanet Foundation, and the World Wide Fund (WWF) for Nature. They used the fixed-wing Carnegie Airborne Observatory (CAO) to develop high-resolution estimates of carbon stored aboveground across a wide range of ecological conditions. The goal was to understand both human

Continued on page 10

Endangered Madagascar Gets Help

Continued from page 9

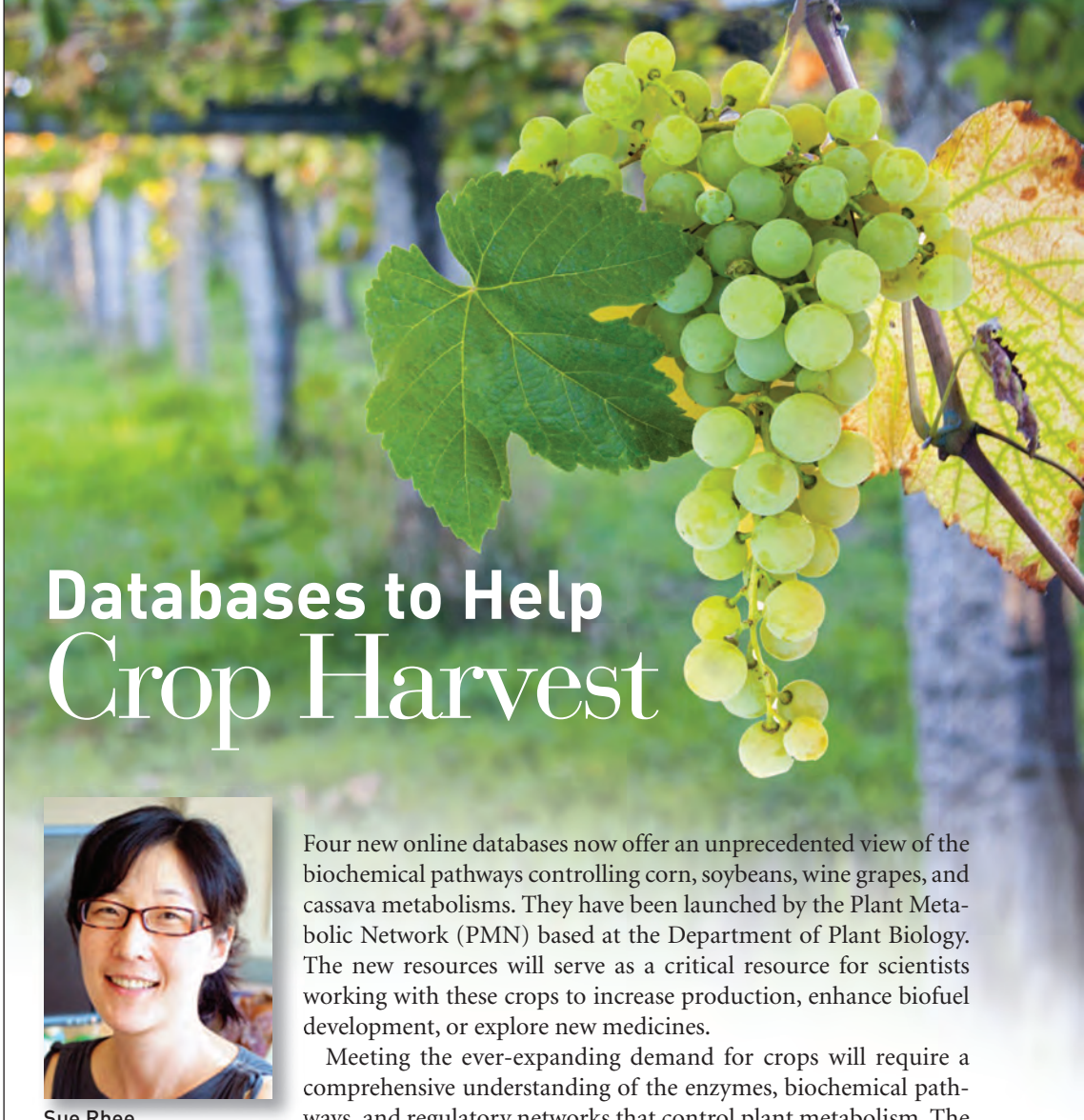
and environmental controls that shape the carbon landscape. The work was published in the February 14, 2012, issue of *Carbon Balance and Management*.

The researchers looked at two areas, one in the north and the other in the south, totaling 9,160 square miles (2,372,680 hectares)—an area about the size of Vermont. In both regions the carbon stocks reached their highest levels at midelevation. Deforestation and forest degradation greatly reduced standing carbon stocks. The scientists also found that carbon stocks in some areas containing secondary forest regrowth varied tremendously, but were consistently lower than in old-growth forests.

"We found that humid mountain forests had the highest carbon densities, while there was less carbon in dry forests and in the lowlands with more human activity," explained lead author Asner. "Despite widespread human activity, we found that large-scale natural controls over carbon stocks were heavily driven by the type of terrain and vegetation cover."

"Madagascar provides an excellent example of the challenges we face in mapping carbon in most tropical regions," remarked Asner. "These results show that we can obtain verifiable carbon assessments in remote tropical regions, which will be a boon not only to science and conservation but to potential carbon-offset programs." □

The Carnegie Airborne Observatory (CAO) flight campaign of Madagascar was supported by Air France, the Andrew Mellon Foundation, and the Carnegie Institution for Science. The CAO is made possible by the Grantham Foundation for the Protection of the Environment, the Gordon and Betty Moore Foundation, the W. M. Keck Foundation, and William Hearst III.



Databases to Help Crop Harvest

Sue Rhee

Four new online databases now offer an unprecedented view of the biochemical pathways controlling corn, soybeans, wine grapes, and cassava metabolisms. They have been launched by the Plant Metabolic Network (PMN) based at the Department of Plant Biology. The new resources will serve as a critical resource for scientists working with these crops to increase production, enhance biofuel development, or explore new medicines.

Meeting the ever-expanding demand for crops will require a comprehensive understanding of the enzymes, biochemical pathways, and regulatory networks that control plant metabolism. The goal of the PMN is to provide a detailed, genome-scale view of the chemical reactions in plant cells, including those that convert carbon dioxide and sunlight into chemical energy, import essential mineral nutrients from the soil into plant roots, aid plants in defending against environmental stress, and otherwise allow plants to maintain life. The PMN helps identify the steps in poorly understood biochemical processes as well as discover unique, previously uncharacterized enzymes.

The research team, led by Carnegie staff scientist Sue Rhee, consists of plant scientists, scientific curators, postdoctoral scholars, and student interns. The group integrates techniques and concepts from a wide range of fields, including molecular sequence analysis, artificial intelligence, statistics, plant molecular biology, and plant biochemistry.

The team created a computational pipeline called E2P2 to place the plant data into a metabolic framework. Importantly, the pipeline allows for a consistent, systematic, and high throughput for metabolism-related analysis of plant genome data. The data is rigorously reviewed using the scientific literature to ensure the quality of each released database. Up to 10 more databases will be forthcoming later this year. Corn, soybeans, wine grapes, and cassava were selected for early release because of their economic and agricultural importance.

"Wine grapes are an important crop for the state of California; corn and soybeans are the number one and two crops of the United States, both as a source of food and biofuel; cassava—also called manioc and yucca—is one of the most common sources of food worldwide and a tremendously important crop for combating hunger," said Rhee. "That's why we decided to release the databases for these plants right away, even before we started preparing a manuscript describing this work, to help researchers get started in improving production and yield of these crucial crops." □

The Plant Metabolic Network is funded by the National Science Foundation.

Volcanoes Deliver Two Flavors of Water

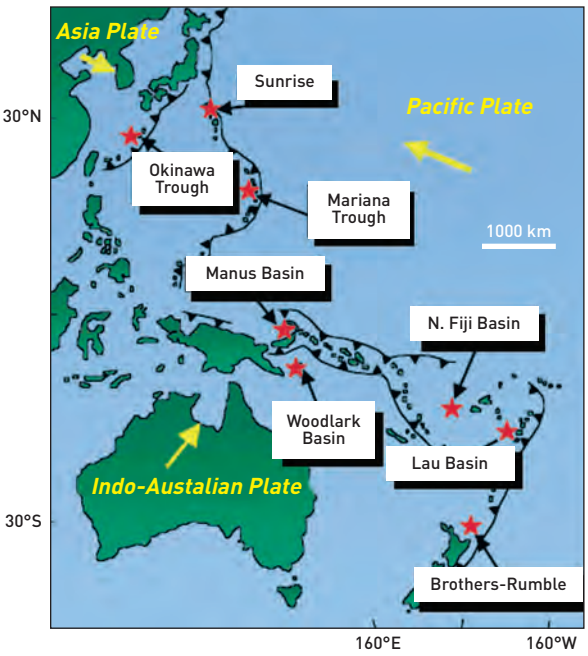


Image courtesy Real Weather

The Manus Basin is shown in this regional map.

Scientists have found evidence that surface water can be carried into the deep Earth by oceanic plates and be preserved for as long as 1 billion years. It also appears that the hydrogen diffusion rates in the deep Earth are much slower than laboratory experiments suggest and that these ancient "slabs" may not only return to the upper mantle in some areas, but they may also come back up in hotspot volcanoes, like those in Hawaii, that are produced by mantle plumes.

Coauthor Eric Hauri, with lead author Alison Shaw and coauthor Mark Behn, both former Carnegie postdoctoral researchers, were members of the investigation team. Circulating seawater pumps hydrogen and boron into the oceanic plates that make up the seafloor, and some of this seawater remains trapped as the plates descend into the mantle at areas called subduction zones. By analyzing samples of submarine volcanic glass near one of these areas, the scientists found unexpected changes in isotopes of hydrogen and boron from the deep mantle. Isotopes are atoms of the same element with different numbers of neutrons.

The researchers expected to see the isotopic "fingerprint" of seawater. But in volcanoes from the Manus Basin of Papua New Guinea, they also discovered evidence of seawater distilled long ago from a more ancient plate descent event, preserved for as long as 1 billion years. The data indicate that these ancient oceanic slabs can return to the upper mantle in some areas, and that rates of hydrogen exchange in the deep Earth may not conform to experiments. The research was published in the February 26, 2012, advance online publication of *Nature Geoscience*.

As Hauri explained, "Hydrogen and boron have both light and heavy isotopes. The volcanoes in the Manus Basin are delivering a mixture of heavy and light isotopes that have been observed nowhere else. The mantle under the Manus Basin appears to contain a highly distilled ancient water that is mixing with modern seawater."

When seawater-soaked oceanic plates descend into the mantle, heavy isotopes of hydrogen and boron are preferentially distilled away from the slab, leaving behind the light isotopes but also leaving it dry and depleted of these elements, making the "isotope fingerprint" of the distillation process difficult to identify. But this process appears to have been preserved in submarine volcanoes in the Manus Basin, which erupted under more than a mile of seawater. Those pressures trap water from the deep mantle within the volcanic glass.

Shaw and Behn recognized another unique feature of the data. Lab experiments have shown very high diffusion rates for hydrogen isotopes, which move through the mantle as tiny protons. This diffusion should have long ago erased the hydrogen isotope differences observed in the Manus Basin volcanoes.

"That is what we typically see at midocean ridges," said Hauri. "But that is not what we found at Manus Basin. Instead we found a huge range in isotope abundances that indicates hydrogen diffusion in the deep Earth may not be analogous to what is observed in the lab."

The results are important to understanding how water is transferred and preserved in the mantle and how it and other chemicals are recycled to the surface. □

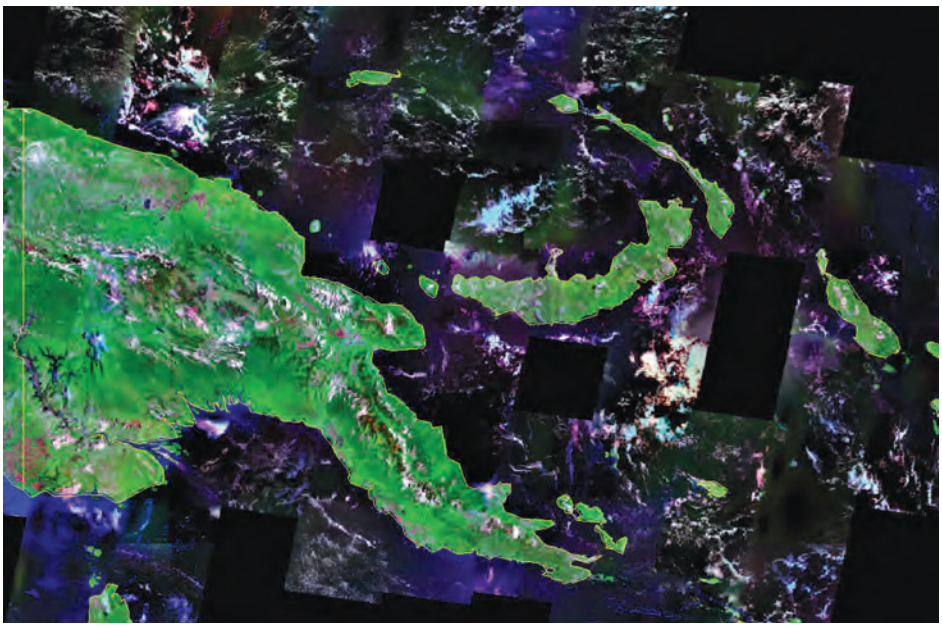


Image courtesy Google Earth

This satellite image shows the terrain in the Papua New Guinea/Manus Basin region.

In addition to Hauri, the team included lead author A. M. Shaw and M. D. Behn, from Woods Hole Oceanographic Institution; D. R. Hilton, Scripps Institution of Oceanography and UC-San Diego; C. G. Macpherson, Durham University; and J. M. Sinton, University of Hawaii.

The Hidden Life of Plants

Guido Grossman

Plant roots hide in the soil and, because of this, root research has lagged behind that for aboveground tissues. Despite their inaccessibility, plant roots are critical to keeping plants thriving; they are the interface between a plant and the soil.

Roots direct the other organs and interact with the surrounding environment. They take up water and essential nutrients and must respond quickly to environmental changes, such as adjusting to rain after a period of drought, responding to different levels of salinization and acidification, and integrating diverse signals such as light and gravity. Understanding roots is crucial to the study of plant physiology, but they have been very difficult to analyze because of their inaccessibility.

Now a new technology called RootChip—developed jointly by Carnegie and Stanford University—could revolutionize root research. The findings were published in the December 2011 issue of *The Plant Cell.*

The research team comprises the paper's lead author, Carnegie's Guido Grossmann, with his Carnegie colleagues Woei-Jiun Guo, David Ehrhardt, and Wolf Frommer, and a group of chemical engineers from Stanford University and the Howard Hughes Medical Institute—Rene Sit, Stephen Quake, and Matthias Meier.

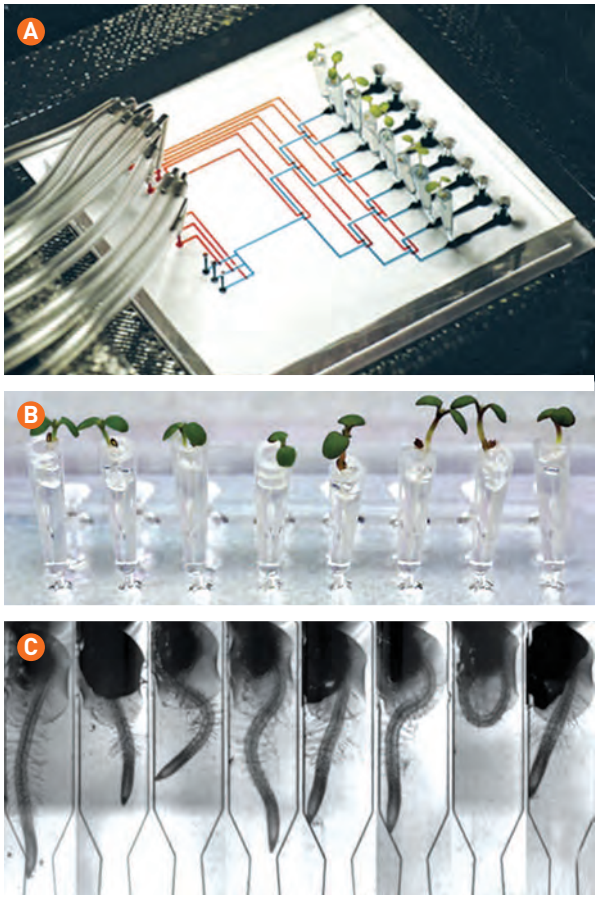


Image used with permission from *The Plant Cell*, 2011 December; 23(12): 4234-4240

The image above of the RootChip shows how the seedlings are monitored (top) and includes a close-up of the seedlings (middle) and the root structures (bottom) seven days after germination. The channels contain red and blue food coloring for illustration.

RootChip allowed the research team to study roots of eight individual seedlings at the same time and to alter their growth environment simultaneously or independently with extraordinary precision. Optical sensors, developed and inserted into the root tissue by Frommer's team, allowed the researchers to examine how the roots responded to changes in nutrient supply levels in real time.

"This new tool provides a major advance for studying root biology at the cellular and subcellular level," said Frommer, director of Carnegie's Department of Plant Biology. "The growth conditions can be freely varied over several days, allowing us to monitor actual growth and development of roots and root hairs and, using our optical biosensors, to study nutrient acquisition and carbon sequestration in real time."

The RootChip was capable of monitoring a root's response to changing levels of the sugar glucose in the surrounding environment. Root growth slowed down when the leaves were not exposed to light, as predicted, because the leaf's photosynthesis is required to supply the energy for root growth. The RootChip also revealed the long-suspected fact that galactose, a sugar highly similar to glucose, is toxic to roots and inhibits their growth and function.

The RootChip is a generic tool and can be altered to test any aspect of root physiology that can be analyzed visually. It can easily be modified to study more than 30 seedlings at the same time and can be expanded for use with plants used to make biofuels, such as *Brachypodium* and foxtail millet. □

This research was supported by grants from NSF and DOE as well as by an EMBO long-term fellowship and the Alexander V. Humboldt Society.

The schematic below shows how RootChip is mounted onto the microscope.

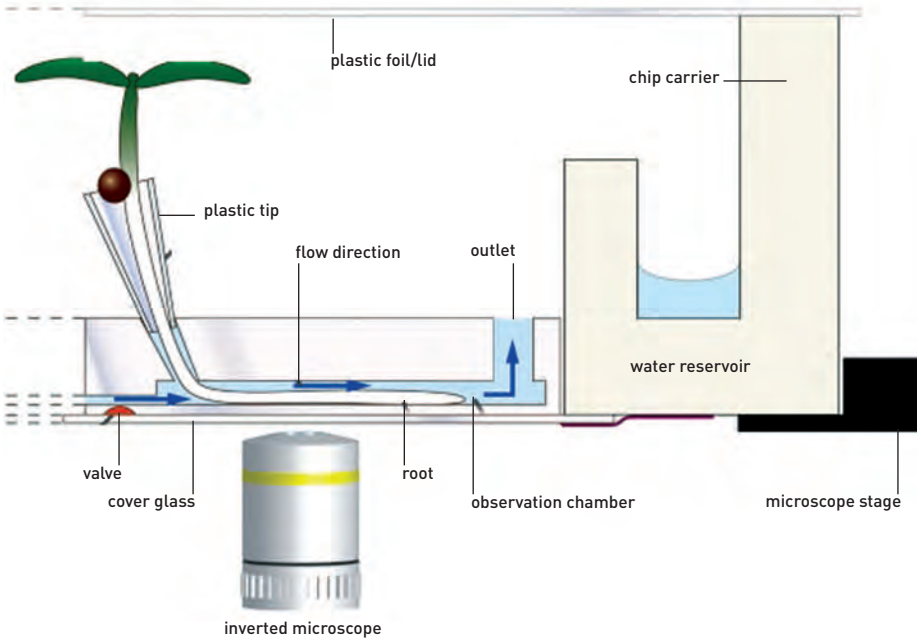
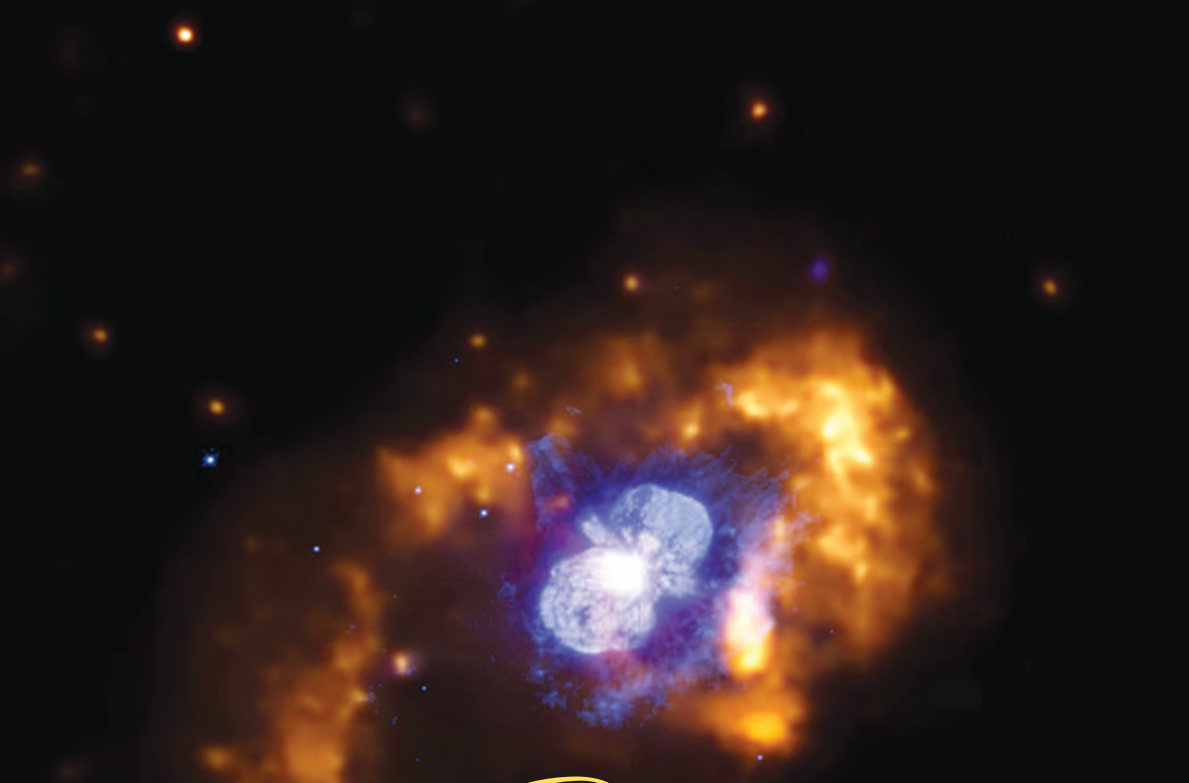


Image used with permission from *The Plant Cell*, 2011 December; 23(12): 4234-4240



Eta Carinae, an extremely bright, unstable star, is about 7,500 light-years from Earth. It is between 100 and 150 times more massive than the Sun. In the 1840s, the star exploded, spewing ejecta more than 10 times the mass of the Sun. This composite image shows the explosion's remnants. The data were taken by NASA's Chandra X-ray Observatory and the Hubble Space Telescope. Blue areas are cool optical emissions of dust and gas.

Image courtesy—X-ray, NASA/CXC/GSFC/M.Corcoran et al.; Optical: NASA/STScI

A RARE *Celestial* ERUPTION

In the 19th century Eta Carinae, one of the most massive stars in our Milky Way Galaxy, unexpectedly increased in brightness. It was the second-brightest star in the sky for 10 years in the mid-1800s. Now it is not even in the top 100. The increased luminosity was so great that it earned the title of Great Eruption. New research from a team including Carnegie's José Prieto, now at Princeton University, used a "light echo" technique to demonstrate that this eruption was much different than previously thought. Their work was published February 16, 2012, in *Nature*.

Eta Carinae is a Luminous Blue Variable (LBV), meaning it has periods of dimness followed by periods of brightness. The variations in brightness of an LBV are caused by increased instability and loss of mass. The Great Eruption was an extreme and unique event in which the star, which is more than 100 times the mass of the Sun, lost several times the mass of the Sun. Scientists believed that the loss was caused by a stellar wind.

The team of scientists, led by Armin Rest of the Space Telescope Science Institute, used images of Eta Carinae over eight years to study light echoes of the Great Eruption. For the first time, they observed light from the eruption that bounced, or echoed, off interstellar dust 10s of light-years from the star. Those extra 10s of light-years mean that the light is reaching Earth now rather than in the 1800s, when people on Earth observed the light that traveled here directly.

They then used the Magellan and du Pont telescopes at Carnegie's Las Campanas Observatory, in Chile, to obtain spectra of the echoes of light. Spectra allow astronomers to separate the light into its constituents, much as a prism separates sunlight into the colors of the rainbow. The spectra gave important information about the chemical composition, temperature, and velocity of the material that was ejected during the 19th-century eruption.

Most surprisingly, their observations showed that the Great Eruption is different from so-called "supernova impostors," events in nearby galaxies that are thought to be eruptions from LBVs. For example, they found that the eruption was significantly cooler than simple stellar-wind models used to explain supernova impostors show. "This star's giant eruption has been considered a prototype for all supernova impostors in external galaxies," Prieto said. "But this research indicates that it is actually a rather unique event."

Scientists still don't know what phenomenon caused Eta Carinae to erupt and lose such mass without being destroyed. Further research is necessary to determine whether other proposed models explain the eruption. □

Observations were made at the Blanco 4m telescope, a facility of the Cerro Tololo Inter-American Observatory; the National Optical Astronomy Observatory, operated by the Association of Universities for Research in Astronomy, under contract with the National Science Foundation. Observations were also obtained at Las Cumbres Observatory Global Telescope Network, and some of the scientists received support from LCOGT. The researchers used data from the UVES Paranal Observatory Project. The computations in this paper were run on the Odyssey cluster supported by the FAS Science Division Research Computing Group at Harvard University. Prieto received support from NASA's Hubble Fellowship.

When complete, the GMT, shown in this artwork, will stand on a solid bedrock foundation.

Image courtesy GMTO.

Mountain Blast and More *for*

THE GIANT MAGELLAN TELESCOPE

On March 23, 2012, onlookers witnessed the first blast to clear 3 million cubic feet of rock from a mountaintop at Carnegie's Las Campanas Observatory to make room for the Giant Magellan Telescope (GMT). Over the next few months, more than 70 controlled blasts will break up the rock, leaving a solid bedrock foundation for the telescope and instrumentation.

At the mountaintop ceremony, Wendy Freedman, director of the Carnegie Observatories and chair of the Giant Magellan Telescope Organization (GMTO), remarked, "Today marks a historic step toward constructing an astronomical telescope larger than any in existence today. Years of testing have shown that Las Campanas is one of the premier observatory sites in the world, and the Carnegie Institution is proud to host the GMT."

On April 2, the GMTO board of directors announced that they had informed the National Science Foundation (NSF) that they will not participate in a funding opportunity. The partners in the project feel that they are making such rapid progress that they have chosen to press ahead at full speed, looking to link up with the NSF at a later date when the needs of both organizations are better aligned.

A GMTO letter to the NSF stated, "After careful consideration, the GMT board has chosen not to pursue this solicitation, but to develop our own program for cultivating partnerships within the U.S. community and with our international partners. We believe this is the best course for the GMT."

The Giant Magellan Telescope is a next-generation astronomical observatory with unprecedented power. Its 85-foot-diameter segmented primary mirror will provide approximately 4,000 square feet of light-collecting area. In the past few months the project has successfully polished the first off-axis mirror segment, cast the second giant mirror, started demolition and earth moving at the site, and selected its first generation of scientific instruments. □

Onlookers at a mountaintop ceremony witnessed the first blast to begin preparing the site for the Giant Magellan Telescope.

Image courtesy Francisco Figueroa/GMTO.

The GMT partner institutions are the Australian National University, Astronomy Australia Limited, the Carnegie Institution for Science, Harvard University, the Korea Astronomy and Space Science Institute, the Smithsonian Institution, Texas A&M University, the University of Arizona, the University of Chicago, and the University of Texas at Austin. More information regarding the GMT project and their statement regarding the NSF solicitation can be found at www.gmto.org.

In Brief

Welcome Cynthia Allen!

Carnegie welcomes Cynthia Allen as its new director of administration and finance. Allen has had a long career serving scientific organizations. She was a program officer and finance and budget manager at the Institute of Medicine at the National Academy of Sciences. After that she held various positions at the Johns Hopkins University including director of finance and administration at the Department of International Health at the Bloomberg School of Public Health and chief operating officer at the McKusick-Nathans Institute of Genetic Medicine. Before coming to Carnegie, she was the associate vice president for administration and chief financial officer at the Associated Universities, Inc. □

TRUSTEES AND ADMINISTRATION

Carnegie president **Richard A. Meserve** spoke on the implications of the Fukushima accident at an event sponsored by the Carnegie Endowment for International Peace on Mar. 6 in Washington, DC. He participated in meetings of the Small Modular Reactor Subcommittee of the Secretary of Energy Advisory Board on Mar. 9 and May 30 in Washington, DC. He spoke at the Japan Society for the Promotion of Science (JSPS)-U.S.-Japan Research Inst. Symposium on Risk Management on Mar. 9 in Washington, DC. He chaired an expert meeting on the Fukushima accident at the IAEA HQ on Mar. 19-22 and a meeting of the IAEA's International Nuclear Safety Group on Apr. 11-13, both in Vienna, Austria. Meserve cochaired a meeting of the National Academies' Committee on Science, Technology, and Law on Mar. 26-27 in Washington, DC. He gave an invited talk on the future of nuclear power at a meeting of the American Physical Society in Atlanta on Apr. 3. He was a guest speaker at an Advisory Council meeting of the Energy Inst. of U. Texas-Austin on Apr. 5 and chaired a meeting of the visiting committee to the Harvard School of Engineering and Applied Sciences on Apr. 23-24. He chaired a meeting of an advisory committee to the Federal Authority for Nuclear Regulation of the United Arab Emirates in Abu Dhabi May 7-8. He was a guest speaker at the Presidents' Circle of the National Academies May 18. He was the cohost of an event sponsored by Carnegie in NYC on May 31 that featured a talk by Paul Butler on extrasolar planets. Meserve gave a lecture on the international nuclear safety regime at the Nuclear Plant Safety Summer Course at MIT on June 11. He participated in meetings of the Dept. of Energy's Nuclear Energy Advisory Committee on June 12.

Carnegie President Richard Meserve

was elected president of the Harvard Board of Overseers for 2012-2013. He attended the Overseers meetings on Mar. 31-Apr.1 and May 22-23. Meserve also received the William S. Lee Award for Industry Leadership at the Nuclear Energy Assembly in Charlotte, NC, on May 22. □

EMBRYOLOGY

❶ Dept. director **Allan Spradling** chaired an external review panel at Duke U. for their Dept. of Cell Biology and was the keynote speaker at the Keystone Symposia "Regenerative Tissue Engineering and Transplantation/Mechanisms of Whole Organ Regeneration." Spradling and postdocs **Vicki Losick** and **Ethan Greenblatt** attended the 2012 Annual *Drosophila* Research Conference in Chicago.

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Joe Gall presented the M. C. Chang Lecture at U. Mass. Medical School in Apr. He also attended the 2012 Annual *Drosophila* Research Conference in Chicago.

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Marnie Halpern gave a seminar at Cincinnati Children's Hospital Medical Center in Apr.

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Yixian Zheng and postdoctoral fellow **Zhonghua Liu** attended the Keystone Symposia "Advances in Basic Science and Therapeutic Applications." Zheng also presented a seminar at the Developmental and Stem Cell Biology Colloquium at Duke U. Apr.18.

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❷ **Steve Farber** gave a seminar at NIH NIDDK, Laboratory of Cellular and Developmental Biology Seminar Series on Mar. 1, "Chewing the Fat with Larval Zebrafish: A Study of Lipid Processing with Guts." On Apr. 17 he talked about "Why We Dip Our Lobster in Butter: Using Zebrafish Larvae to Uncover an Unexpected Linkage between Dietary Fat and Cholesterol Absorption" for the Inst. of Molecular Biology, U. Oregon-Eugene weekly seminar series.

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Gotthard Sághi-Szabó

Chief Information Officer **Gotthard Sághi-Szabó** was given the CRISC Worldwide Excellence Award for being the top exam scorer in the world for "certified in risk and information systems control" in Dec. 2011. CRISC is a certification for information technology professionals with experience in managing IT risks awarded by ISACA—formerly known as the Information Systems Audit and Control Association. ISACA currently serves more than 95,000 members in 160 countries. □

Alex Bortvin presented the Mar. Johns Hopkins U. biology dept. colloquium lecture "Hopes and Fears: Transposons in the Germline."

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Nick Ingolia presented seminars at the Albert Einstein Coll. of Medicine, Bronx, NY; Case Western Reserve U., Cleveland, OH; The Johns Hopkins Medical Inst., Baltimore; and U. Maryland-College Park.

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In Apr. **Christoph Lepper** was an invited speaker at the Keystone Symposia "Regenerative Tissue Engineering and Transplantation/Mechanisms of Whole Organ Regeneration" in Breckenridge, CO.

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Zheng lab postdoc **Haiyang Chen** attended the 2012 Annual *Drosophila* Research Conference in Chicago.

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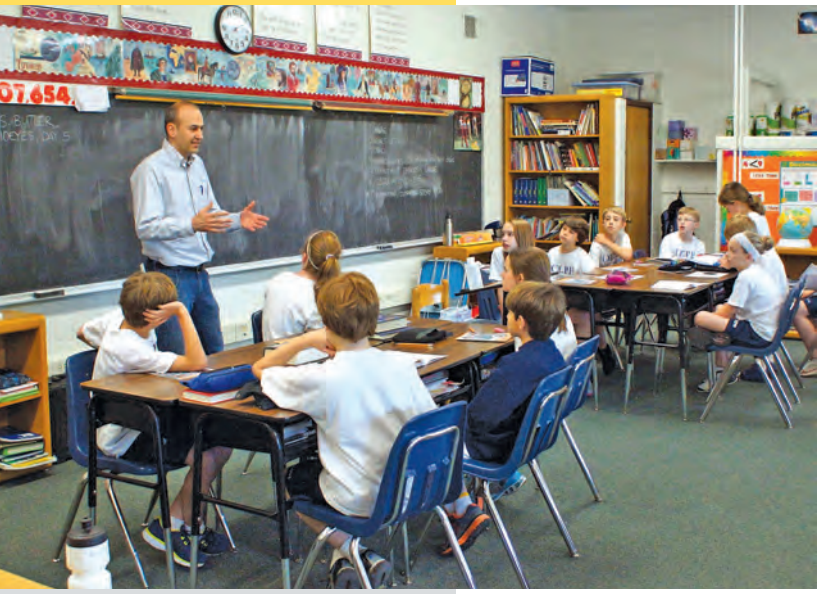
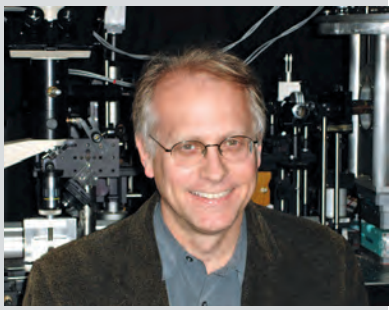
Image courtesy Christine Pratt

❶ Past and present Spradling lab members gathered for dinner at the 2012 Annual *Drosophila* Conference in Chicago. Front row, left to right: Mary Lilly, John Tower, Brian Calvi, Margarete Heck, Denise Montell, Todd Nystul, Celeste Berg, Bob Glaser, Erika Matunis, Allan Spradling, and Trudi Schupbach. Back row, left to right: Horacio Frydman, Ting Xie, Tina Tootle, Vanessa Damm, Lynn Cooley, Ethan Greenblatt, Rachel Cox, Jim Wilhelm, Bob Levis, Maggie DeCuevas, Daniela Drummond-Barbosa, and Vicki Losick.



❷ Steve Farber talks to students in the BioEYES program.

❸ Joe Gall and Zehra Nizami



❹ Geophysical Lab director Rus Hemley

❺ Robert Hazen

❻ Yoko Kebukawa

❸ Gall graduate student **Zehra Nizami** defended her Ph.D. thesis, "Structure and Function of Cajal Bodies and Histone Locus Bodies in *Drosophila* and *Xenopus* Nuclei," on Mar. 30.

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Johns Hopkins undergraduate **Alice Chen** received a Provost's Research Award to continue her research in the Halpern lab over the summer. Halpern lab graduate student **Vanessa Matos-Cruz** was selected to participate in "A Systems Biology Approach to Understanding Mechanisms of Organismal Evolution," a satellite short course of the Sixth International Meeting of the Latin American Society for Developmental Biology at U. de la Republica & Institut Pasteur de Montevideo in Montevideo, Uruguay, Apr. 16-25. She also presented her research at the meeting.

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Arrivals: Postdoc **Ethan Greenblatt** joined the Spradling lab; postdoc **Shiying Jin** is new to the Fan lab; postdoc **Erik Duboué** joined the Halpern lab; **Sheryl Murray** is a new postdoc in the Lepper lab; **Marlow Minor** joined as an animal technician in the fish facility; and **Chandra Harvey** is a new Carnegie Science Outreach Coordinator for BioEYES.

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Departures: Animal technician **Freddie Jackson** left the frog facility.

GEOPHYSICAL LABORATORY

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❹ Director **Russell Hemley** presented an invited talk on "Energy Materials in Extreme Environments" at the American Physical Society Mar. meeting in Boston Feb. 27-Mar. 2. On Apr. 16 he presented a talk at Carlow U. in Pittsburgh, PA, titled "Molecules under Pressure."

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❺ **Robert Hazen** was awarded the Outstanding Faculty Award, the highest academic honor in the state of Virginia, at a ceremony at the statehouse in Richmond. He presented lectures on mineral evolution, origins of life, and mineral-molecule interactions at UC-Davis, Brown U., U. Maryland, U. South Dakota, and the Smithsonian Institution. He also presented lectures at the annual meeting of the American Chemical Society in San Diego and at the Astrobiology Science Conference in Atlanta.

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Anat Shahar gave a talk at the Lunar and Planetary Science Conference. In addition, she received a Blaustein Fellowship from Stanford.

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❻ Carnegie Fellow **Yoko Kebukawa** gave a talk at the Gordon Research Conferences: Origin of Life Jan. 8-13 in Galveston, TX.

GLOBAL ECOLOGY

On Apr. 7 **Chris Field** was interviewed on NPR's *All Things Considered* and was quoted in their article "Sunny Days Are Here Again—But Is That Good?"

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❼ The Carnegie Airborne Observatory (CAO) team mapped the country of Panama during Jan. and Feb. to develop the first high-resolution carbon estimates of a tropical nation. The CAO team also mapped a portion of the Colombian Amazon in support of scientific research and capacity building with the government of Colombia.

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❽ **Ken Caldeira** summering in Germany visiting the Inst. for Advanced Sustainability Studies (IASS) and the Potsdam Inst. for Climate Impact Research (PIK) in Potsdam. He is giving seminars at the Max Planck Inst. in Hamburg, the Alfred Wegener Inst. in Bremerhaven, and the Leibniz Inst. of Marine Sciences in Kiel. His trip will end with teaching at the Global Sustainability Summer School and the Urbino Summer School in Paleoclimatology. Caldeira, with postdoc **Ben Kravitz**, participated in the "Planet under Pressure" meeting in London in Mar. Ben gave a talk about sunshade geoengineering, and Ken presented a poster about carbon dioxide emissions in international trade.

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❾ **Abhishek Chatterjee** of the Michalak lab has been awarded the 2012 NOAA Climate and Global Change Postdoctoral Fellowship. As part of this prestigious fellowship, he will be joining the National Center for Atmospheric Research (NCAR) in Boulder, CO, from Dec. 2012, where he will be developing a data assimilation system to improve CO_2 source attribution, including fingerprinting the role of anthropogenic forcing on carbon cycle dynamics. At NCAR, he will be jointly hosted by Jeff Anderson (NCAR-IMAGe) and Joe Tribbia (NCAR-CGD).

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❿ The Field lab's **Rebecca Hernandez** has been awarded a $60,000 Ford Foundation Predoctoral Fellowship, administrated by the National Academies, providing three years of financial support and access to the Ford Fellows Liaison Network.

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Asner lab postdoc **Joe Mascaro**'s op-ed, "Following Newt to the Moon," was printed in *The Space Review* on Feb. 13.

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Caldeira postdoc **Steve Davis** was featured in KUOW's EarthFix Conversations. The discussion was "Counting Up Coal's CO_2." Davis tallied the amount of greenhouse gas emitted as coal makes its way from Wyoming to China.

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Arrivals: Eric Slessarev is a new intern in the Berry lab. **Claire Baldeck** joined the Asner lab as a postdoc on Mar. 16. **Guillaume Tochon**, a visiting graduate student from France, will be working with the Asner lab for six months. Another Asner visitor, **Alessandro Baccin**, comes from the Woods Hole Research Center.

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Departures: Leander Love-Anderegg left the Berry lab in Feb. **Long Cao**, postdoc in the Caldeira lab, left on Mar. 27 for a teaching position in China. **Julia Pongratz** left her position as a postdoc in that lab and returned to Germany, where she works at the Max Planck Inst. in Hamburg. **Gabriela Meckler** left her intern position in the Asner lab on Feb. 27.

THE OBSERVATORIES

Jan. 14 **Wendy Freedman**, chair of the Giant Magellan Telescope (GMT) board, attended GMT's second mirror casting event at the Steward Observatory's Mirror Lab in Tucson, AZ. On Jan 25-27 she gave an invited talk on "Measuring the Hubble Constant to High Accuracy" at the Origins Inst.'s Workshop "Coming Opportunities in Physical Cosmology" at ASU. She was an invited speaker at "The Hubble Constant: Current and Future Challenges" workshop on Feb. 6 at the Kavli Inst. for Particle Astrophysics and Cosmology, Stanford U. She attended the ASU Origins Project External Advisory Board's meeting on Feb. 11 in Scottsdale, AZ. On Feb. 28 Freedman attended a dinner in honor of Nobel Laureate Brian Schmidt at the home of the Australian ambassador, Kim Beazley. During Mar. 1-9 she visited the Center for Astrophysics, Harvard U. On Mar. 23 she attended the first dynamite blasts at the site of the GMT at Las Campanas, with Eva Pell, undersecretary of the Smithsonian Institution, and Charles Alcock, director of the Center for Astrophysics at Harvard U.

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❼ The Carnegie Airborne Observatory above is operated onboard a Dornier 228 aircraft. It features customized avionics, instruments, and sensors to map tropical forests around the world.

❼ Postdoc Robin Martin at right works in the Panamanian forest analyzing spectra and plant chemistry.


❽ Ben Kravitz


❾ Abhishek Chatterjee


❿ Rebecca Hernandez


⓫ Andrew McWilliam


⓬ Mansi Kasliwal


⓭ Arthur Grossman

Staff astronomer **Luis Ho** coorganized and gave an invited talk at a workshop at IPMU, Tokyo, titled "Growing Black Holes in COSMOS." He also gave a colloquium at Hong Kong U.

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⓫ In Jan. staff astronomer **Andrew McWilliam** served as an external member of the Sloan-III review committee for the APOGEE Stellar Parameters and Chemical Abundances Pipeline (ASPCAP) in Fort Worth, TX.

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In Mar. staff astronomer **Michael Rauch** gave a talk about intergalactic turbulence at the conference on "Turbulence in Cosmic Structure Formation" at Arizona State U.

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Staff astronomer **Josh Simon** attended the conference "First Light and Faintest Dwarfs in Santa Barbara" Feb. 13-17 and gave the talk "Extremely Metal-Poor Stars in the Least Evolved Galaxies."

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In Jan. postdoctoral research associate **Nimish Hathi** attended the AAS meeting in Austin, TX, and presented his work on the physical properties of Lyman break galaxies at z=1-3. He was a judge for the Chambliss Poster Award. In Feb. he was awarded an AAS Small Research Grant.

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In Jan. postdoctoral research associate **Rik Williams** gave a talk titled "Carnegie-Spitzer-IMACS Survey: The Rise of Galaxy Groups Since z=1" at the 219th AAS meeting in Austin, TX. In Feb. he gave an invited colloquium titled "Galaxy Assembly in the Thermal Era" at U. Kentucky.

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⓬ In Jan. Hubble-Carnegie-Princeton Fellow **Mansi Kasliwal** gave a conference talk titled "Physics of Astronomical Transients" in Aspen, CO, and a colloquium at Las Cumbres Observatory Global Telescope Network, Goleta, CA. In Feb. she gave the talk "A Celebration of Novae" in Pasadena, CA, and a WUNCH Seminar talk in Princeton, NJ. In Mar. she gave a Hubble Symposium talk in Baltimore.

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In Jan. Carnegie Fellow **Ian Roederer** attended "The Chemical Evolution of the Milky Way" in Sesto, Italy, and gave a talk "r-process Dispersion in Metal-Poor Globular Clusters." In Mar. he attended The Ninth Russbach Workshop on Nuclear Astrophysics in Russbach, Austria, and gave an invited talk titled "New Observations to Explore r-process Nucleosynthesis."

PLANT BIOLOGY

Director **Wolf Frommer** gave a talk on Mar. 22 at RIKEN-Brain Research Inst., Wako City, Japan, titled "FRETting over Sugars: Can Plants Help Us Understand Cellular Glucose Efflux in Humans?" On Mar. 23 he presented a seminar at Tokyo U. titled "Fluorescent Biosensors for Studying Carbon and Nitrogen Transport." He gave another talk at RIKEN, Yokohama, Japan, on Mar. 24 and on Mar. 25 he attended the Japan Society for Bioscience, Biotechnology, and Agrochemistry (JSBBA) Conference in Kyoto and was the keynote speaker at the Symposium on Nutrient Transport. He spoke about "Raiding the SWEET Shop—How Pathogens Gain Access to the Plant's Nutrient Resources."

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Winslow Briggs attended the Gordon Conference held Jan. 22-27 in Galveston, TX, and spoke on "Photosensory Receptors and Signal Transduction."

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⓭ **Arthur Grossman** joined the advisory board for the UTEX Culture Collection of Algae, which includes approximately 3,000 different strains of living algae. Cultures in the collection are used for research, teaching, biotechnology development, and various other projects worldwide. Grossman is now editor-in-chief for the *Journal of Phycology* with a team of three other scientists. On Jan. 5-8 he attended the Western Photosynthesis Conference held in Pacific Grove, CA.

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On Jan. 20 **Zhiyong Wang** gave a seminar at Clemson U. titled "Brassinosteroid Signaling and Regulation of Plant Development." On Jan. 30 he attended the Temasec Life Science Laboratory 10th Symposium in Singapore and presented another talk on brassinosteroid signaling. On Feb. 27 he gave a seminar about brassinosteroids at UCLA.

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⓮ **Martin Jonikas** and postdoctoral associate **Ru Zhang** attended the 21st Western Photosynthesis conference held in Pacific Grove, CA, on Jan. 5-8. Zhang presented a talk titled "Comprehensive Identification of Genes Essential for Photosynthesis and Growth under High Light Using a Novel, High-Throughput

⓮ Martin Jonikas

⓯ Eva Huala

In early Apr. **Erik Hauri** collected samples of ash, tephra, and scoria from individual cinder cones (Pu'u) in Hawaii that form as a result of volatile-driven fire fountain eruptions on Kilauea and Mauna Loa volcanoes. These quickly cooled cinders provide the best samples to obtain melt inclusions that have trapped preeruptive contents of water and carbon dioxide in Hawaiian magmas. Two such cinder cones are shown on the horizon in the photo.

Rick Carlson Elected to National Academy of Sciences

Geochemist Richard Carlson of Carnegie's Dept. of Terrestrial Magnetism has been elected a member of the National Academy of Sciences (NAS). He is among 84 new members and 21 foreign associates of one the most prestigious honorary societies in the country. Carlson studies the chemical and physical processes that formed the terrestrial planets. Using the known decay rates of various radioactive isotopes, he investigates the chronology of early heat-intensive processes on small planetary objects and studies the chemical and physical aspects of old and young crust-forming processes on Earth. □

Genomic Tool." Jonikas also was invited by Michigan State U. students to give a talk on Mar. 12 titled "Changing the Pace of Photosynthesis Research by Doing 100,000 Experiments at Once."

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José Dinneny gave a seminar on Mar. 9 at UC-San Diego titled "A Spatiotemporal Understanding of Environmental Response in *Arabidopsis* Roots." He also attended the Maize Genetics Conference, Portland, OR, Mar. 15-18.

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Matt Evans presented a talk at the symposium "Plant Reproduction for Food" held Jan. 13-17 in Melbourne, Australia.

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⓯ **Eva Huala** attended the conference on "Plant and Animal Genomes" in San Diego Jan. 14-16 and gave two talks about the mining of *Arabidopsis* data and a TAIR update.

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Postdoctoral research associates **Antony Cheettor** and **Yongxian Lu** presented posters at the 54th Annual Maize Genetics Conference held Mar. 15-18 in Portland, OR.

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Mark Heinnickel, a postdoctoral research associate in the Grossman lab, attended the Western Regional Photosynthesis Conference in Pacific Grove, CA, Jan. 5-8.

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Arrivals: Postdoctoral research associate **Yuanhu Xuan** arrived on Jan. 16 from Gyeongsang National U., South Korea, to join the Frommer lab. Also arriving on Jan. 30 for a six-month stay was **Bo Larsen,** a visiting student from U. Copenhagen. The Briggs lab welcomed **Rajnish Khanna,** senior investigator from Mendel Biotechnology on Mar. 6. Postdoctoral research associate **Xenie Johnson** joined the Grossman lab on Feb. 1 from La Trobe U., France. On Nov. 22 postdoctoral research associate **Meng Xu** arrived from U. Science & Technology of China to join the Rhee lab. On Mar. 5 **Ricardo Nilo Poyanco**, visiting student from U. Andres Bello, Chile, also joined the lab. The Ehrhardt lab welcomed Carnegie Fellow **Jelmer Lindeboom** on Jan. 2 from Wageningen U. in the Netherlands. The Barton lab welcomed postdoctoral research associate **Nidhi Sharma** on Jan. 2 from U. Texas-Austin.

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Departures: Interns who left Carnegie at the end of the fall intern program were **Brandon Araki**, **Tara Chandran**, **Sairupa Paduchuri**, and **Rick Kim**. Curator **Philippe Lamesch** ended his position in the TAIR group on Mar. 7 to return to Luxembourg as the Cultural Outreach Coordinator. **Dorianne Moss** left the Ehrhardt lab on Dec. 31 to spend more time with her children. The Frommer lab had a farewell party to send off lab technician **Sam Parsa** at the end of Dec. to attend graduate school. **Jianxiu Shang**, a visiting student in the Wang lab, left on Mar. 23 to return to Hebei Normal U. in China.

TERRRESTRIAL MAGNETISM

In Feb. director **Lindy Elkins-Tanton** presented a series of lectures during a field trip to Mt. Kilimanjaro in Tanzania. In Mar. she gave a lecture at Stony Brook U.-New York. She also gave two talks at the Lunar and Planetary Science Conference and two other coauthored talks. In Apr. she was the 2012 Cloos Lecturer at Johns Hopkins and gave invited talks at U. British Columbia and at the European Geosciences Union conference in Vienna.

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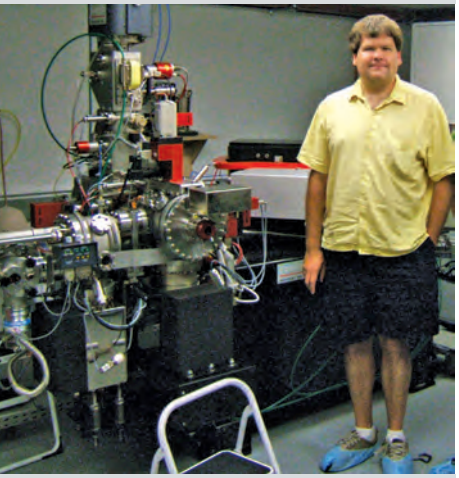
⓰ **Sean Solomon** has been named the new director of Columbia U.'s Lamont-Doherty Earth Observatory. He will take a leave of absence and head to NYC this summer. In Feb. he chaired a meeting of the MESSENGER Science Team in Tempe, AZ, hosted by Arizona State U. He delivered seminars on findings from MESSENGER's orbital mission at the Space Telescope Science Inst. in Feb. and at Caltech in May. In Mar. he chaired a special session of presentations on science from MESSENGER's first year in Mercury orbit at the Lunar and Planetary Science Conference, held in The Woodlands, TX, and he participated in a media briefing on several of the latest mission results. In May he chaired

⓰ Sean Solomon



⓱ Larry Nittler

another meeting of the MESSENGER Science Team in Vancouver, hosted by U. British Columbia.

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⓱ **Larry Nittler** has been named deputy principal investigator of the MESSENGER mission. In Feb. he attended a MESSENGER Science Team meeting in Tempe, AZ, gave a colloquium at U. Arizona, gave an invited talk at a workshop on "Solar System Exploration and New Geosciences—Perspective for the Next Decade" in Misasa, Japan, and performed some measurements at the Advanced Light Source at Lawrence Berkeley National Lab. In Mar. Nittler hosted former postdoc Ming-Chang Liu, who spent a week at DTM performing measurements with the NanoSIMS. In Apr. he hosted former postdoc Henner Busemann, also for a week of NaonSIMS measurements. In May Nittler attended a MESSENGER Science Team meeting in Vancouver, BC, and gave an invited talk at the Annual Workshop on Secondary Ion Mass Spectrometry in Philadelphia.

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In Feb. **Alan Boss** attended the annual meeting of the AAAS in Vancouver, BC, and participated in the AAAS Council meeting as the retiring chair of the Astronomy Section. Also in Feb. Boss chaired a meeting of the NASA Advisory Council's (NAC) Astrophysics Subcommittee (APS) at NASA HQ in Washington, DC, and he presented the APS Letter Report to a meeting of the NAC Science Committee held at NASA HQ in Mar. He then presented the report of the NAC Science Committee to the meeting of the NAC itself, also held in Mar. at NASA HQ. That month Boss gave an invited colloquium at the Jet Propulsion Laboratory (JPL) in Pasadena, CA. Boss was also the 2012 Carl K. Seyfert Lecturer at Vanderbilt U., Nashville, TN. He spoke at the Lunar and Planetary Science Conference in Houston, TX, about particle trajectories and thermal processing in the solar nebula. In Apr. Boss gave an invited colloquium about the latest exoplanet discoveries at Pontifical Catholic U. in Santiago, Chile. Also in Apr., Boss participated in a meeting of the Kepler Mission Science Team, held at NASA Ames Research Center, in Moffett Field, CA. In May he was an invited speaker at a workshop on solar nebula particles and at the Japanese Geophysical Union meeting, both in Tokyo. At the end of May Boss participated in the NASA Exoplanet Exploration Program Technical Advisory Committee's review of exoplanet imaging technology test beds at NASA Ames and JPL.

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In Apr. **John Chambers** gave a colloquium at Southwest Research Inst. titled "The Role of Fragmentation in Late Stage Planet Formation."

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In Feb. and Apr. **Diana Roman** delivered departmental colloquia at Cornell, the Smithsonian, and Lamont-Doherty. She also conducted fieldwork at Telica Volcano, Nicaragua, in early May.

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In Mar. and May **Susan Benecchi** visited Las Campanas Observatory. She is studying the rotation rates of Kuiper Belt Objects. Benecchi gave a talk at U. Maryland in Feb. and then gave two talks in Apr. at Towson U. and The Space Telescope Science Inst. in Baltimore.

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⓲ In Apr. postdoctoral fellow **Brian Jackson** revisited Death Valley to continue his geology fieldwork on Racetrack Playa. Jackson and his colleague Ralph Lorenz visit the Playa semiannually to deploy equipment to monitor the meteorological conditions and the rock motion.

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Postdoctoral fellow **Nicholas Moskovitz** visited Niigata, Japan, in May for the "Asteroids, Comets, Meteors" conference and presented two posters: "The Near-Earth Encounter of Asteroid 2005 YU55: Time Resolved Visible and Near-infrared Spectroscopy" and "Rotational Properties of V-type Asteroid 2579 Spartacus."

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Fifteen members of DTM traveled to Texas and presented their latest research at the 43rd Lunar and Planetary Science Conference on Mar. 19-23: **Conel Alexander**, **Alan Boss**, **Paul Byrne**, **Richard Carlson**, **Linda Elkins-Tanton**, **Shaun Hardy**, **Mary Horan**, **Christian Klimczak**, **Nick Moskovitz**, **Larry Nittler**, **Zan Peeters**, **Scott Sheppard**, **Sean Solomon**, **Shoshana Weidner**, and **Jianhua Wang**.

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Arrivals: In Feb. **Sabrina Ferrarri**, MESSENGER predoctoral fellow, visited DTM. Ferrarri is pursuing her Ph.D. at U. Padua. She worked with postdoctoral fellows **Paul Byrne** and **Christian Klimczak** on the mapping of tectonic structures on Mercury. Also in Feb. **Wang Cheng** visited from China's Nanjing U. to work with **Jianhua Wang** in the ion probe laboratory for two months looking for toxic elements found in rice. **Kaitlin Howell**, a senior physics major at George Mason U., worked with Larry Nittler from Feb. until the end of May on Mercury and the study of solar grains. **Valentina Taranovic** arrived during Feb. She is a Ph.D. student at Indiana U., where she is studying magmatic ore deposits. Taranovic studied the Ni-Cu-PGE deposits with Steve Shirey and Mary Horan. Deep Carbon Observatory Postdoctoral Fellow **Jared Marske** arrived in Mar. He received his Ph.D. in geology and geophysics at U. Hawaii-Manoa and works closely with Erik Hauri. Visiting investigator **Dmitri Ionov** visited in Apr. Ionov and Rick Carlson sampled the young basaltic volcanic rocks and mantle xenoliths of the Hangay Plateau, Mongolia, to understand why this midplate region is so geologically active. In Apr. **Ryan Porter** arrived as the newest Carnegie Fellow, collaborating with Matt Fouch. He completed his Ph.D. in seismology at U. Arizona. He studies earthquake seismology, active tectonics, crustal and upper mantle structure, subduction zone processes, and seismic anisotropy.

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Departures: In May **Stacey S. Matusko** departed DTM to pursue other opportunities.

DTM/GL

Shaun Hardy participated in the American Geophysical Union's second Meeting of Librarians, in San Antonio, TX, in Mar. He also attended the American Geosciences Inst.'s GeoRef Advisory Committee meeting in Alexandria, VA, in Apr. □

⓲ Brian Jackson is on Racetrack Playa in Death Valley.

Image courtesy Brian Jackson

Carnegie Institution for Science
1530 P Street, NW
Washington, D.C. 20005-1910

Image courtesy Shelley Johnson

(Above) Marnie Halpern, staff scientist at Embryology, represented the Society of Developmental Biology as a Nifty Fifty speaker. She went to Our Lady of Perpetual Help school in Ellicott City, Maryland. Postdoctoral associates Troy Horn (shown here instructing students about zebrafish) and Erik Duboué, as well as Valerie Butler from BioEYES, participated. Festival organizer Larry Bock and Steve Farber, founder of BioEYES, were also on hand. Farber additionally conducted BioEYES demonstrations at the festival throughout the weekend.

(Right) Terrestrial Magnetism's Steve Shirey engages young visitors at the Carnegie booth in the D.C. Convention Center.

(Far right) Toby Horn (left, in yellow), codirector of the Carnegie Academy for Science Education, ran experiments and explained what was going on as visitors observed.

Year Two with the USA Science & Engineering Festival

Carnegie was again a partner in the second USA Science & Engineering Festival held in Washington, D.C., this April. It is the country's only national science festival and was originated to increase public awareness of the importance of science and engineering and to attract the next generation to science and engineering careers. Festival partners include the most prestigious science and engineering organizations, academic institutions, and more. The event had over 3,000 hands-on activities and over 100 stage shows, all for free. To get local students interested, the festival sent out 100 Nifty Fifty scientists to nearby schools in advance. The scientists were selected from hundreds of nominees from science and engineering societies, universities and colleges, federal agencies and laboratories, and science outreach organizations. Carnegie scientists were selected for the Nifty Fifty and volunteered to man the Carnegie booth and engage visitors. □

Image courtesy Toby Horn

Image courtesy Toby Horn