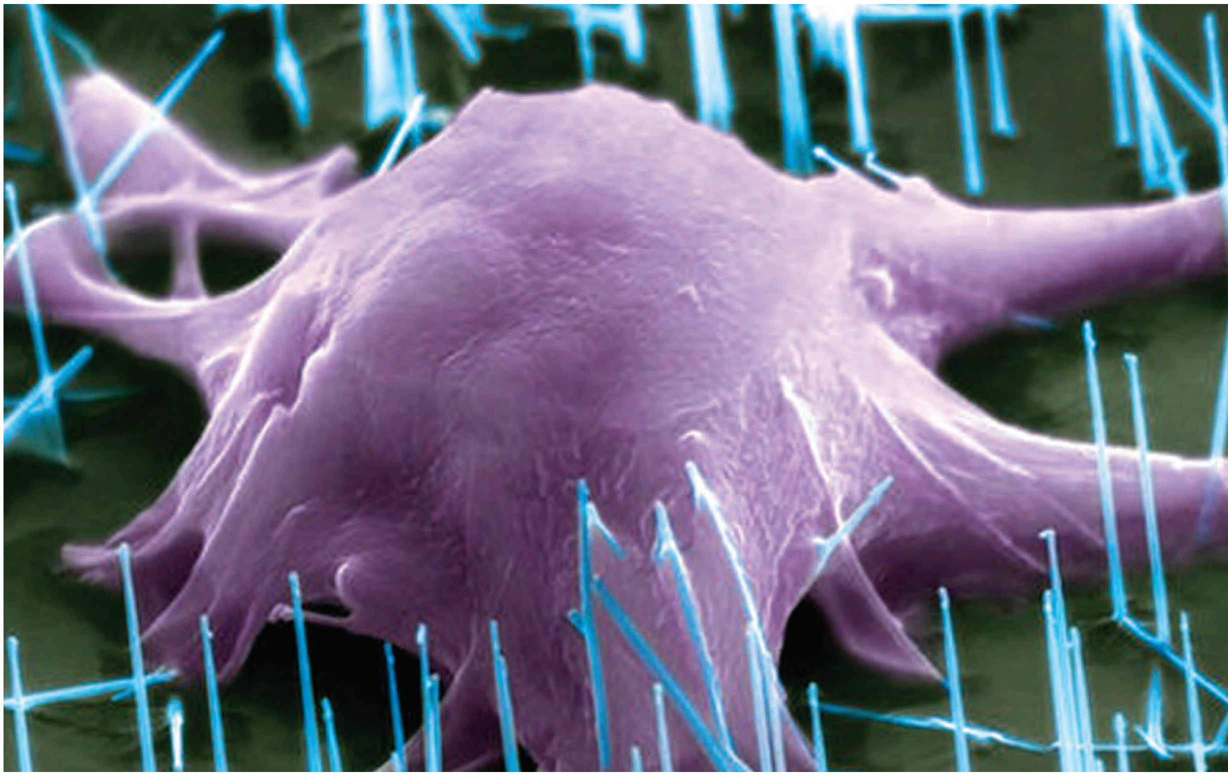
CarnegieScience

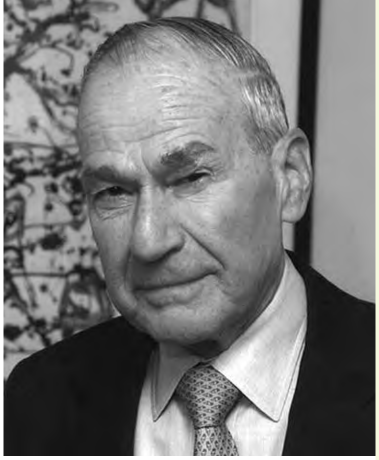
The Newsletter of the Carnegie Institution

SPRING 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 CHAIRMAN

FOR 110 YEARS CARNEGIE'S BOARD OF TRUSTEES has successfully charted the course of the institution—in good times and in bad. The very first board, assembled in 1902, included the secretary of state, the secretary of war, the commissioner of labor and, to the delight of Andrew Carnegie, Theodore Roosevelt, the president of the United States as an ex-officio member. Subsequent trustees have included a host of diverse and outstanding individuals: Presidents William H. Taft and Herbert Hoover, banker Henry S. Morgan, Senator Henry Cabot Lodge, David Rockefeller, DuPont CEO Richard Heckert, astronaut Sally Ride, and William Hewlett, cofounder of Hewlett-Packard, to name a few.

The main goal of the first board was to secure America's global leadership in scientific research. But the means to find and nurture "exceptional" people was left to the trustees and president with precious little guidance. As it turned out, the key was flexibility. Carnegie had the foresight to include a clause in the deed of trust specifying that the trustees could change funding practices to accommodate "the changing conditions of the time."

In the early years, the Executive Committee ran the institution. They assembled an advisory board of experts to identify the most important academic questions of the day. Initially, they supported extraordinary researchers with individual grants. Just a short time later, however, they established research facilities, and by 1907 there were 10 departments. During those early years the board also learned how to terminate work that no longer showed promise. Flexibility would prove to be the foundation for success.

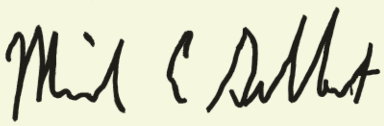
During the Great Depression, the institution had to contend with hard choices. Rather than retreat, the board realized that basic research was vital to pull humanity out of its current "emergency," as it was called. The Executive and Finance committees preserved the most promising programs and eliminated the least. They left vacancies open and froze salaries. The strategy worked, and the institution remained strong and productive.

World War II brought a different problem. The trustees sought to support the national war effort. The entire enterprise moved from basic research to applied research, with nearly every staff member advancing war-related projects. The administration building became home to the Office of Scientific Research and Development, the central hub of the government's efforts over a wide range of technological advances. Carnegie president Vannevar Bush directed the department. Flexibility was crucial again after the Allied victory. Rather than maintain the current course of applied research, the trustees made a rapid adjustment back to fulfill Carnegie's original mission of basic science.

Board members in more recent years have also had to adjust strategies to bolster the institution. In the 1970s, in response to a declining endowment, they authorized efforts to secure federal funds for some Carnegie projects. In the late 1980s board members embarked on the institution's first capital campaign, which began a fundraising trend that continues today.

Today's board is a diverse and talented group from business, academia, public service, and even the film industry. Each member brings a unique perspective to the challenge of advancing the institution's mission through the pursuit of exciting new projects. It is clear that after 110 years of adapting well, even thriving under changing circumstances, Andrew Carnegie's emphasis on flexibility has proven pivotal.

Michael E. Gellert, *Chairman*



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

Members of one trustee tour group examine some of the tanks where different varieties of zebrafish are cared for.

Predoctoral fellows Pavol Genzor (left) and Valeriya Gaysinskaya of the Bortvin lab describe the process by which egg and sperm fuse into a developing zygote.

Howard Hughes Medical Institute postdoctoral associate Lucy Morris of the Spradling lab, using novel imaging techniques developed in the lab, describes how tissue is built and repaired in the ovary of the fruit fly. Trustee Stephen Fodor looks on.

Steven Farber (foreground, with vest) presides over visitors to the BioEYES lab. The tour group looked into microscopes with zebrafish at varying stages of development, just as BioEYES students do during the BioEYES program.

FISH, FLIES, MICE, AND MORE at the Trustees Meetings

The 135th meeting of the Carnegie Institution for Science board of trustees took place over two days, November 17 and 18, 2011, at the Maxine F. Singer Building of the Department of Embryology in Baltimore. After the first session of the board, the trustees broke into groups and were conducted on two-and-a-half hour tours of the labs guided by pre- and postdoctoral fellows.

First on one tour was the Farber lab's zebrafish facility. Here the trustees learned how the lab uses the tiny, clear, developing zebrafish to study how lipids are metabolized and how cholesterol and lipids are packaged into cells. They saw how the lab is organized for genetics studies and how the fish are cared for.

Tracking estrogen in waterways was the topic at the Halpern lab. Its researchers have developed mutant zebrafish that can detect estrogen in water by glowing fluorescent green when the hormone is present. The achievement is potentially important for determining estrogen pollutants, which can alter the reproductive organs of fish.

What prompts muscle stem cells in mice to jump into action after injury was featured in the Fan lab. That group explained how they look at satellite cells in muscles to determine their relationship to stem cell a ctivity. The Zheng lab showcased how novel imaging techniques enable tracking the stem cells of preimplanted mice embryos "in the wild."

Imaging techniques were also featured in the Bortvin lab to observe how germ cells—those that develop into egg and sperm—grow into egg and sperm and fuse into a zygote. The Bortvin lab is particularly interested in the time at which so-called jumping genes are active. These genes are DNA segments that are able to move from one location to another. The research could help in the study of infertility problems.

The Spradling lab studies the fruit fly. On this tour stop the trustees looked at how tissue is built and repaired in the ovary of the fruit fly, using novel imaging techniques developed in the lab that can track stem cells in live tissue. Studies of the fruit fly affect research into how human stem cells could be used to treat injury, disease, and aging.

Finally, the trustees got a lesson on BioEYES, the educational and outreach program founded by Steve Farber. BioEYES has two programs created for K-12 students with great success in Baltimore and elsewhere. In the first, a week program, the children husband zebrafish from the egg into a clear embryo, where they can study the organs at work inside. Older students use the fish for genetics studies. The second program, *Your Watershed, Your Backyard,* is two weeks long. It looks at the health of the waterways in the region by collecting samples to monitor water quality and to subject zebrafish to area water to see if it is healthy enough for the fish to survive.

After the tours department staff, trustees, and guests dined at the Glass Pavilion on the Johns Hopkins campus. The featured speaker was staff member Joe Gall. His talk, "Basic Research or Technology—Who Is in the Driver's Seat?" looked at whether science drives technology or technology drives science. Gall described how, beginning in the 1600s, the field of optics drove the science of astronomy. He then turned to the history of the microscope. Initially the technology drove the science, but in the mid- to late 19th century questions in biology began to drive the technology. He noted how little the microscope had changed until about a decade ago when changes led to viewing at smaller and smaller scales. That, in turn, has pushed new scientific discoveries in genetics, development, and more. □

New Superhard Carbon Debuts

Carbon, one of the most abundant elements in the universe, takes on a wide variety of forms called allotropes, ,with hardness ranging from diamond to graphite. Scientists at the Geophysical Laboratory are part of a team that has discovered a new form of carbon that is capable of withstanding extreme pressure stresses that were previously observed only in diamond. The discovery, published in *Physical Review Letters*, could lead to new ultradense, strong materials.

The team was led by Stanford University's Wendy L. Mao and her graduate student Yu Lin and includes Carnegie's Ho-kwang (Dave) Mao (Wendy's father), Li Zhang, Paul Chow, Yuming Xiao, Maria Baldini, and Jinfu Shu. The experiment started with a form of carbon called glassy carbon, which was first synthesized in the 1950s and was found to combine desirable properties of glasses and ceramics with those of graphite. The team created the new carbon by compressing glassy carbon to above 400,000 times normal atmospheric pressure.

This new carbon form was capable of withstanding 1.3 million times normal atmospheric pressure in one direction while confined under a pressure of 600,000 times atmospheric levels in other directions. No substance other than diamond has been observed to withstand this type of pressure stress.

However, unlike diamond and other crystalline forms of carbon, the structure of this new material is not organized in repeating atomic units. Its structure lacks the long-range order of crystals, making it amorphous. This amorphous, superhard carbon would have a potential advantage over diamond if its hardness were equally strong in all directions because diamond's hardness is highly dependent upon the direction in which the crystal is oriented.

"These findings open up possibilities for potential applications, including superhard anvils for high-pressure research, and could lead to new classes of ultradense and strong materials," said Russell Hemley, director of Carnegie's Geophysical Laboratory. □

This research was funded in part by the U.S. Department of Energy's Office of Basic Energy Sciences Division of Materials Sciences and Engineering and EFree, HPCAT is funded by DOE-BES, DOE-NNSA, NSF, and the W. M. Keck Foundation. APS, is supported by DOE-BES.

The new superhard form of carbon could rival diamonds in strength.

Jumpin' Genome

THE GENOME IS A HOPPING PLACE. It contains numerous "jumping genes," or transposons, which move from place to place on the chromosomes within a cell. An astounding 50% of human DNA comprises both active transposons and remains of former transposons that were active thousands to millions of years ago.

If all of this mobile and formerly mobile DNA were not mysterious enough, every time a plant, animal or human cell prepares to divide, the chromosome regions richest in transposon-derived sequences, even elements long deceased, are among the last to duplicate. The reason for their delayed duplication has eluded biologists for more than 50 years.

New research led by Carnegie's Allan Spradling and published online in the *Proceedings of the National Academy of Sciences* provides potential insight into both these enigmas. The scientists used the fruit fly, *Drosophila melanogaster.* They focused on one particular transposon, called the *P* element, which has an unsurpassed ability to move.

Remarkably, *P* elements have only been present in *Drosophila melanogaster* for about 80 years, at which time they were acquired from the genome of a distantly related fruit fly species by an unknown process. *P* elements remain highly "infective" today. By adding just one copy to one fly's genome, all the flies with which it breeds acquire 30 to 50 *P* elements within a few generations. The original goal of the Spradling team's research was to learn why *P* elements insert at some locations in the genome but not others.

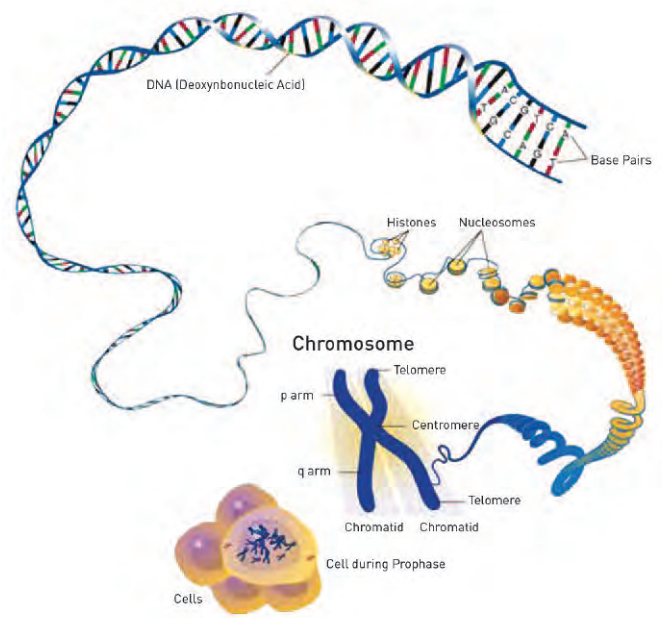


Image courtesy the National Human Genome Research Institute

Chromosomes are packages of DNA, genetic material, in the nucleus of all cells. Transposons, also known as jumping genes, can jump around and become inserted into different locations in a chromosome. Some 50% of human DNA consists of active and relic transposons.

Allan Spradling at left, is the director of Carnegie's Department of Embryology.

Spradling and his colleagues, who oversee the NIH-funded *Drosophila* Gene Disruption Project, used a database that they built over the last 20 years containing more than 50,000 genomic sites where *P* elements have inserted.

P elements insert into DNA very selectively. Nearly 40% of new jumps occur within just 300 genes and always near the beginning of the gene. But the genes seemed to have nothing in common. When these sites were compared with data about the *Drosophila* genome, particularly recent studies of *Drosophila* genome duplication, the answer became clear. What many *P* insertion sites share in common is an ability to function as starting sites for DNA duplication. This association between *P* elements and the machinery of genome duplication suggested that they can coordinate their movement with DNA replication.

Spradling and his team propose that *P* elements—and likely other transposons as well—use a replication connection to spread more rapidly through genomes. These elements would only jump after replicating, and then preferentially insert themselves into portions of DNA that have not yet become activated. This would allow them to duplicate twice rather than just once during the genome duplication cycle—once in the first location and a second after the jump.

If the elements get a late start, however, only the last segments of the chromosome to duplicate will be left for their second duplication. This explains the tendency of such regions to be transposon rich. However, the researchers found that two other *Drosophila* transposons, known as *piggyBac* and *Minos*, do not insert at replication origins, so this mechanism is far from universal. Furthermore, Spradling cautioned that it is particularly difficult to experimentally test hypotheses about evolution.

"By gaining insight into one specific transposon's movements, we may have begun to glimpse mechanisms that have profoundly influenced genome evolution for nearly all animals," Spradling commented. □

Spradling's coauthors on the paper are Hugo Bellen of Baylor College of Medicine and Roger Hoskins of Lawrence Berkeley National Laboratory. Funding for this research was provided in part by the National Institutes of Health.

EARTH'S OXYGEN-DEPRIVED CORE

Although the composition of the Earth's solid inner core is a mystery, scientists know that the liquid outer core is mainly iron. Current models show that in addition to large amounts of iron, the outer core contains small amounts of so-called light elements; possibly sulfur, oxygen, silicon, carbon, or hydrogen. Since oxygen is the most abundant element on the planet, it was thought that oxygen might be one of the dominant light elements. New laboratory experiments by a team including Carnegie's Yingwei Fei, however, show that oxygen does not have a major presence in the outer core. This finding, published November 24, 2011, in *Nature,* could alter our understanding of Earth's formation.

In this research Fei, from the Geophysical Laboratory, worked with Chinese colleagues, including lead author Haijun Huang from China's Wuhan University of Technology. The team mimicked pressure and temperature conditions of the outer core in the lab.

Pressure and heat increase with increasing depths, and materials act differently at these depths than they do at the surface. The light elements are thought to play an important role in driving the convection of the liquid outer core, which generates the Earth's magnetic field.

Scientists know the variations in density and speed of sound as a function of depth in the core from seismic observations, but to date it has been difficult to measure these properties in proposed iron alloys at core pressures and temperatures in the laboratory. "We can't sample the core directly, so we have to learn about it through improved laboratory experiments combined with modeling and seismic data," Fei said.

High-speed impacts can generate shock waves that raise the temperature and pressure of materials, melting them at pressures corresponding to those in the outer core. The team carried out shock-wave experiments on mixtures of iron, sulfur, and oxygen. Once these mixtures were liquid at outer-core conditions, the team measured their density and the speed of sound traveling through them.

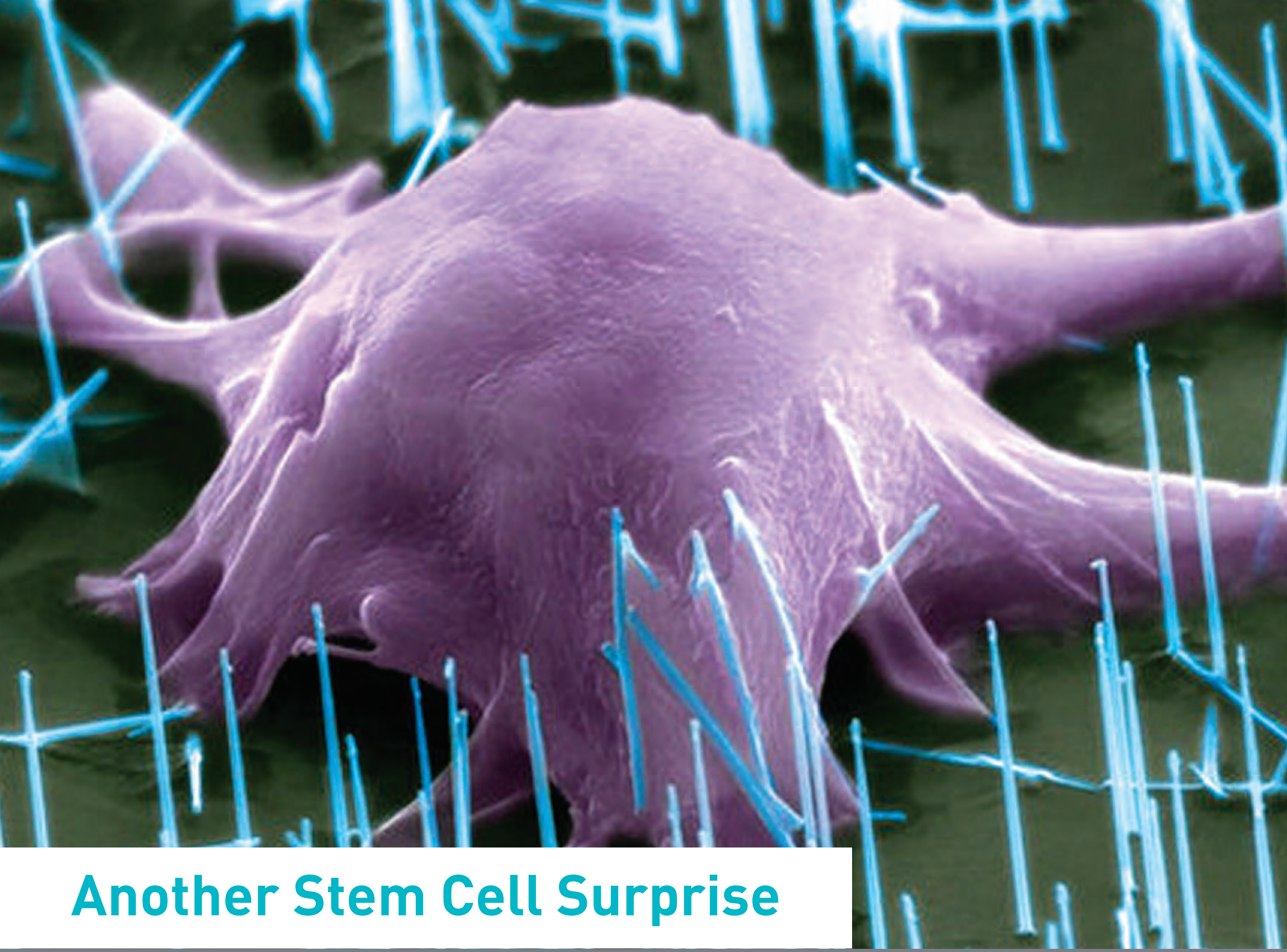
The researchers compared their data with observations and found that the experiments on oxygen-rich materials do not align with geophysical observations. They conclude that oxygen cannot be a major light-element component of the Earth's outer core, supporting recent models of core differentiation in early Earth under less oxidized environments, leading to the presumption of a core that is poor in oxygen.

"The research revealed a powerful way to decipher the identity of the light elements in the core. Further research should focus on the potential presence of elements such as silicon in the outer core," Fei said. □

(Top) This cutaway of Earth shows the crust (black), the mantle (light orange), the liquid outer core (dark orange), and the solid inner core (yellow).

The Geophysical Laboratory's Yingwei Fei, at left, works in the high-pressure lab.

Portions of this work were supported by grants from the National Natural Science Foundation of China, the Fundamental Research Funds for the Central Universities, and the National Basic Research Program of China, as well as the National Science Foundation and the Carnegie Institution for Science.



Another Stem Cell Surprise

Image courtesy Peidong Yang, Lawrence Berkeley National Laboratory

UNTIL NOW, SCIENTISTS THOUGHT that proteins called B-type lamins were essential for embryonic stem cells to replicate and differentiate into different varieties of cells. New research from a team led by the Department of Embryology's Yixian Zheng indicates that B-type lamins are not necessary for stem cells to renew and develop after all. But they are necessary for proper organ development. The team's work was published in the November 24, 2011, *Science Express*.

Nuclear lamina is the material that lines the inside of a cell's nucleus. Its major structural component is a family of proteins called lamins, of which B-type lamins, or lamin-Bs, are prominent members and thought to be absolutely essential for a cell's survival. Mutations in lamins have been linked to a number of human diseases. Lamins are thought to suppress the expression of certain genes by binding directly to the DNA within the cell's nucleus.

The role of B-type lamins in the differentiation of embryonic stem cells into specialized cells, depending on where in a body they are located, was thought to be crucial. The lamins were thought to use their DNA-binding suppression abilities to tell a cell which type of development pathway to follow.

But the team—which included Carnegie's Youngjo Kim, Katie McDole, and Chen-Ming Fan—took a hard look at the functions of B-type lamins in embryonic stem cells and in live mice and found that they were not essential for embryonic stem cells to survive, nor did their DNA binding directly regulate the genes to which they were attached. However, mice deficient in B-type lamins were born with improperly developed organs—including defects in the lungs, diaphragms, and brains—and were unable to breathe.

"Our work seems to indicate that while B-type lamins are not part of the early developmental tissue-building process, they are important in facilitating the integration of different cell types into the complex architectures of various developing organs," Kim, the lead author, said. "We have set the stage to dissect the ways that a cell's nuclear lamina promotes the tissue organization process during development." □

(Above) This color-enhanced mouse embryonic stem cell was cultured on a silicon nanowire and is viewed via a scanning electron microscope.

Other members of the team were Alexei Sharov and Minoru Ko of the National Institutes of Health and Melody Cheng, Haiping Hao, and Nicholas Gaiano of The Johns Hopkins University School of Medicine. This research was supported in part by the Intramural Research Program of the National Institute on Aging (AAS, MSHK) and the Howard Hughes Medical Institute.

Diamonds Reveal Deep Carbon Cycle

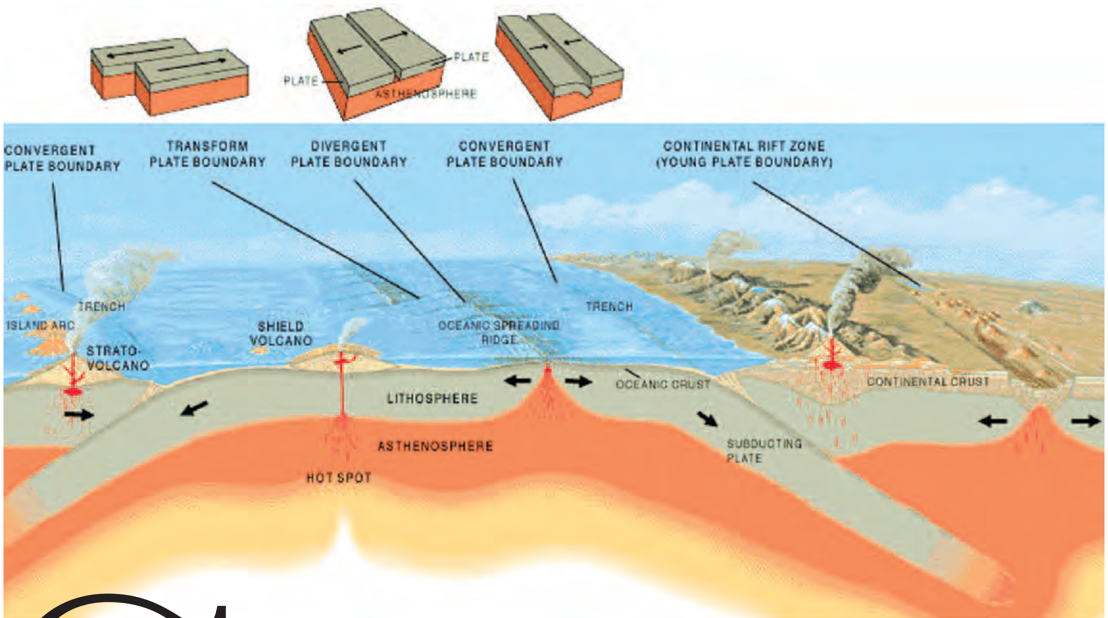


Image courtesy U.S. Geological Survey, the Smithsonian Institution, and the U.S. Naval Research Laboratory

SCIENTISTS HAVE SPECULATED for some time that the Earth's carbon cycle extends deep into the planet's interior, but until now there has been no direct evidence. The mantle—Earth's thickest layer—is largely inaccessible.

A team of researchers, including Carnegie scientists, analyzed diamonds that originated from the lower mantle at depths of 435 miles (700 kilometers) or more and erupted to the surface in volcanic rocks called kimberlites. The diamonds contain mineral inclusions—what gemologists call impurities. Analysis shows compositions consistent with the mineralogy of oceanic crust. This finding is the first direct evidence that slabs of oceanic crust sank or subducted into the lower mantle and that material, including carbon, is cycled between Earth's surface and depths of hundreds of miles. The research was published in the September 15, 2011, online *Science Express.*

The mantle extends from as little as 5 to 1,800 miles (10 to 2,900 kilometers) beneath the Earth's surface. Most diamonds are free from inclusions and come from depths of less than 120 miles (200 km). But in a few localities researchers have found superdeep diamonds from the depths of the convecting upper and lower mantle as well as the transition zone in between. Whereas inclusions in diamonds from the depths of the upper mantle and the transition zone have been consistent with a surface-rock origin, none from the lower mantle have borne this signature until now.

The team was led by former Carnegie postdoctoral fellow Michael Walter, now a professor at the University of Bristol, U.K., and included Terrestrial Magnetism's Steve Shirey, Eloise Gaillou, and Jianhua Wang, in addition to Andrew Steele from the Geophysical Lab. The scientists analyzed tiny (one- to two-hundredths of a millimeter) mineral grains from six diamonds from the Juina region in Brazil. They found that diamond inclusions initially crystallized as a single mineral that could form only at depths of greater than 435 miles (700 km). But the inclusions recrystallized into multiple minerals as they were carried up to the surface—first probably from a mantle upwelling known as a plume, then as they erupted to the surface in kimberlites.

The diamonds were analyzed for carbon at Carnegie. Four of the diamonds contained low amounts of carbon-13, a signature not found in the lower mantle and consistent with an ocean-crust origin at Earth's surface. "The carbon identified in other superdeep, lower-mantle diamonds is chiefly mantlelike in composition," said Shirey. "We looked at the variations in the isotopes of the carbon atoms in the diamonds. Carbon originating in a rock called basalt, which forms from lava at the surface, is often different from that which originates in the mantle with relatively less carbon-13. These superdeep diamonds contained much less carbon-13, which is most consistent with an origin in the organic component found in altered oceanic crust."

"I find it astonishing that we can use the tiniest of mineral grains to show some of the motions of the Earth's mantle at the largest scales," concluded Shirey. □

This diagram above shows the oceanic crust sliding under the continental crust in a process called subduction. This new study is the first direct evidence that slabs of oceanic crust sank into the lower mantle and that various materials, including carbon, are cycled between the planet's surface and depths hundreds of miles below.

The researchers on the paper are M. J. Walter, S. Kohn, G. Bulanova, and C. Smith of the University of Bristol, U.K.; D. Araujo of Universidade de Brasilia-DF Brazil; A. Steele of Carnegie's Geophysical Laboratory; and S. Shirey, E. Gaillou, and J. Wang of Carnegie's Department of Terrestrial Magnetism. Funding was provided by the National Science Foundation in the U.S., the National Environmental Research Council in the U.K., and the Carnegie Institution for Science.

Image courtesy Stanford News Service

Trembling Aspens

OVER THE PAST 10 YEARS, the death of forest trees due to drought and increased temperatures has been documented on all continents except Antarctica. This can drive global warming by reducing the amount of carbon dioxide removed from the atmosphere by trees and by releasing carbon locked up in their wood. New research led by Carnegie researcher and Stanford University Ph.D. student William Anderegg offers evidence for the physiological mechanism governing tree death in a drought. The work was published by the *Proceedings of the National Academy of Sciences.* In addition to Anderegg, the authors included Carnegie's Chris Field and Joe Berry, William's brother Leander, and Duncan Smith and John Sperry of the University of Utah.

Forests store about 45% of the carbon found on land. Their mortality can radically transform ecosystems, affect biodiversity, harm local economies, pose fire risks, and increase global warming. Scientists have had two competing theories to explain how forest trees die during a drought. One theory proposes that the trees starve because of decreased photosynthesis. The other proposes that death occurs because the system for transporting water within a tree is damaged beyond repair by stress. Without knowing which theory is correct, it is difficult for researchers to build models and make projections about the larger impact of drought-induced forest mortality. The team focused their efforts on climate-induced die-offs of trembling aspen trees in North America, looking directly at the relationship of both carbon starvation and water-transportation stress to ongoing forest deaths.

The aspen die-off, called Sudden Aspen Decline, or SAD, began after severe droughts between 2000 and 2004 and affected about 17% of aspen forests in Colorado as well as in parts of the western United States and Canada. SAD continued through 2010, the year the research was conducted.

"Large-scale mortality events, such as we see with aspens, are the dynamite in ecosystem responses to climate change. We know that when they occur, they make a huge difference. But we are at the early stages of being able to predict occurrence," said Field, director of Carnegie's Department of Global Ecology.

The team found no evidence of significantly decreased carbon reserves in SAD-affected aspens. This undercuts the starvation theory, although it is possible that carbon starvation had occurred and had already been rectified. However, the team did find notable losses of function in the trees' water-transportation systems, especially in the roots. SAD-affected trees showed about a 70% loss of water conductivity. Potted trees exposed to a summer's worth of drought exhibited significant root mortality.

"Our study provides a snapshot of what future droughts could hold for the emblematic tree of the American West. Our results indicate that an impaired ability to transport water due to drought damage played an important role in the recent die-off of aspens," William Anderegg said.

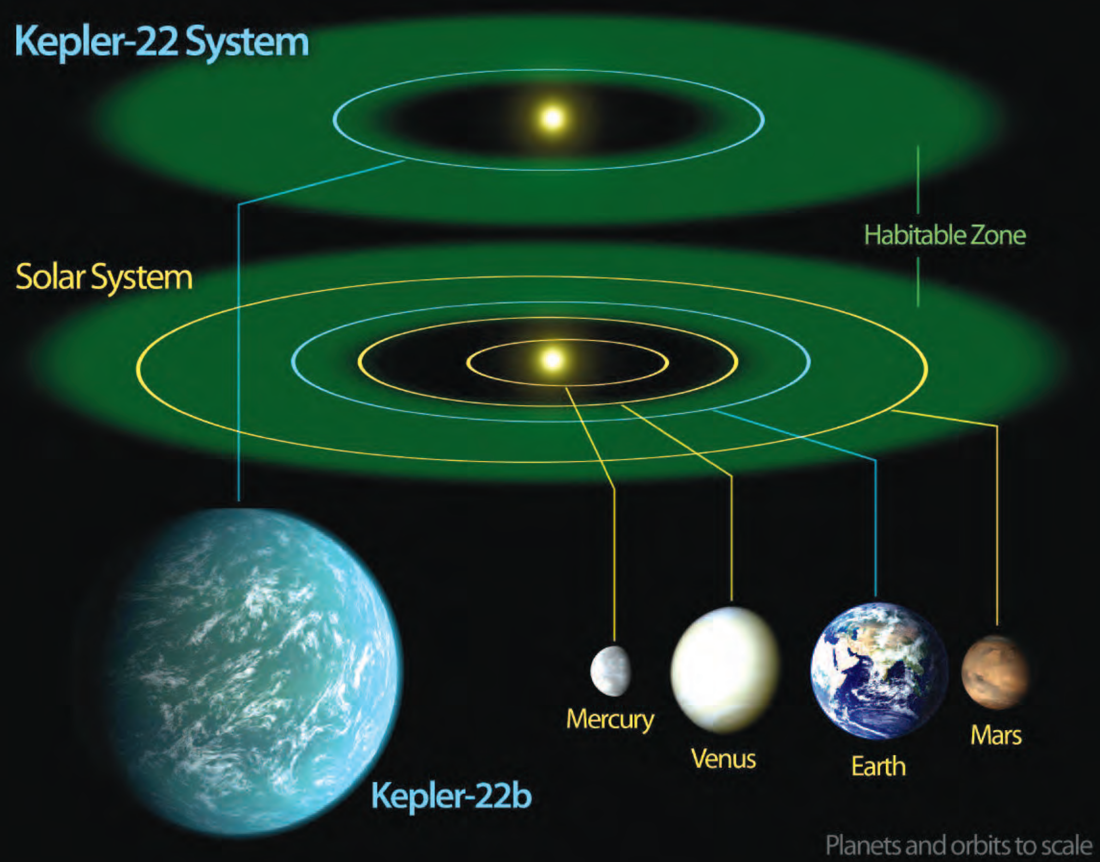
The team's work will provide guidance for scientists seeking to build models and projections of forest mortality as a result of climate change. □

(Above) William Anderegg prepares to measure the aspen canopy.

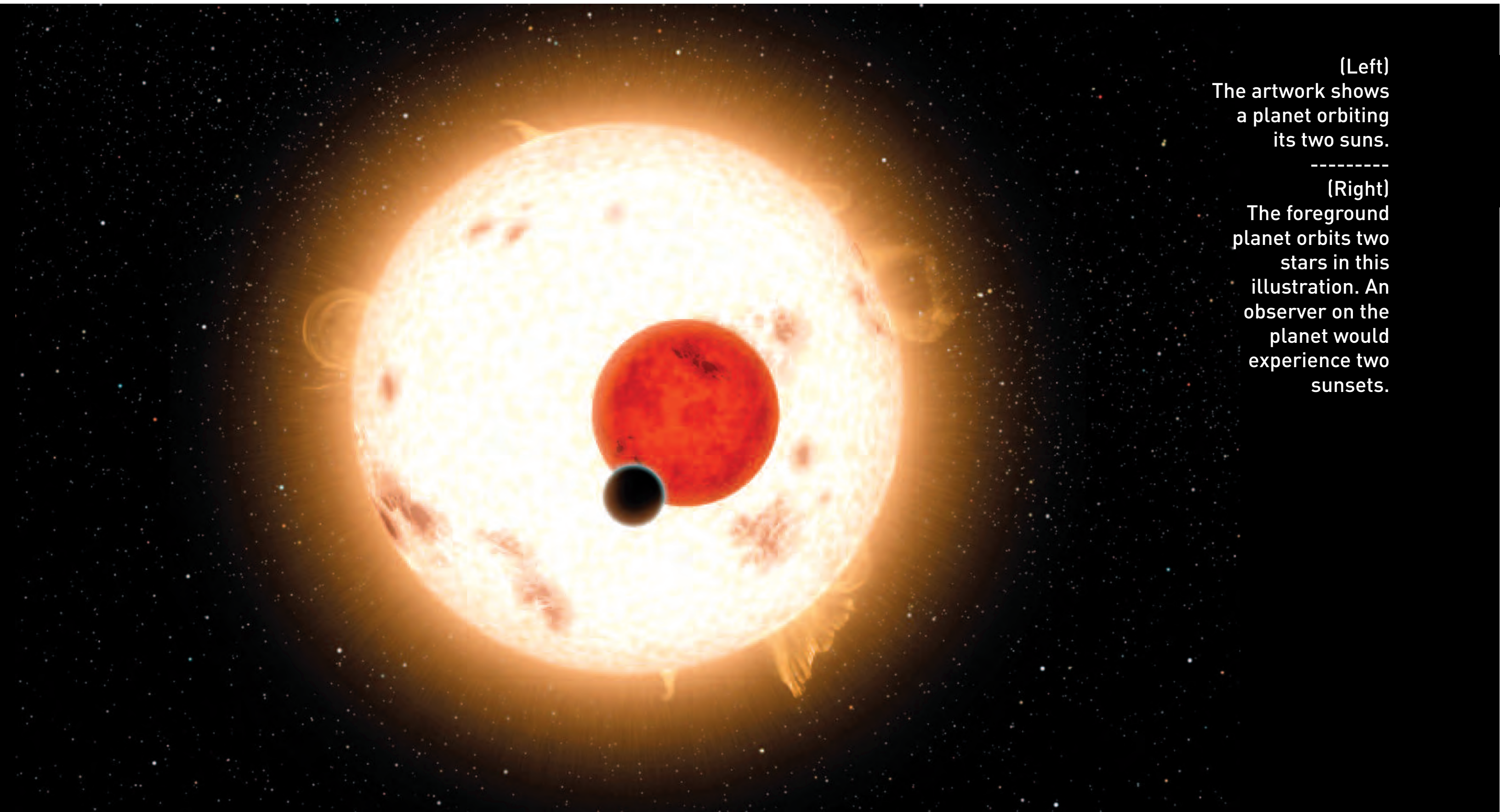
Funding and equipment for this research were provided by Stanford University's Bill Lane Center for the American West, the Morrison Institute, the Phi Beta Kappa Northern California Association, the Jasper Ridge Biological Preserve, the Stanford University Department of Biology, and the U.S. Department of Energy Office of Science Graduate Fellowship Program. This program was made possible by the American Recovery and Reinvestment Act of 2009 and is administered by the Oak Ridge Institution for Science and Education, managed by the Oak Ridge Associated Universities for DOE.

(Right)
This illustration shows the new habitable-zone planet's solar system compared with ours. The new planet has been dubbed Kepler-22b.

(Far right)
This artist's conception shows a planet in the habitable zone of a Sun-like star in the region around a star where liquid water could exist at the surface. NASA's Kepler mission has confirmed the existence of such a planet for the first time. It is 2.4 times the size of Earth—the smallest planet yet found to orbit in the middle of the habitable zone of a G star like our Sun.

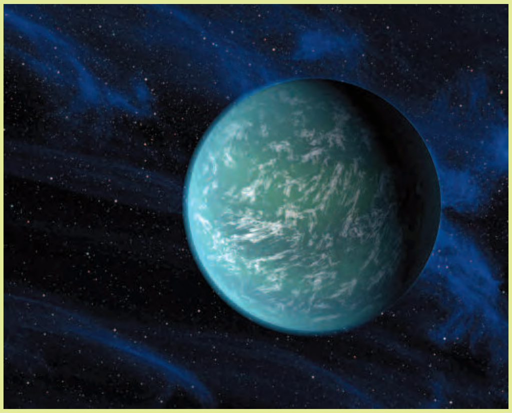


Double Bonanza *for* Exoplanets



(Left)
The artwork shows a planet orbiting its two suns.

(Right)
The foreground planet orbits two stars in this illustration. An observer on the planet would experience two sunsets.



First Habitable-Zone Super-Earth

A proliferation of extrasolar planet discoveries has kept Terrestrial Magnetism's Alan Boss particularly busy of late. He served on a team that discovered the first super-Earth orbiting in the habitable zone of a star similar to the Sun. It appears to be a large, rocky planet with a surface temperature of about 72°F. This discovery, published in the *Astrophysical Journal,* is the first detection of a possibly habitable world in orbit around a Sun-like star.

The discovery team, led by William Borucki of the NASA Ames Research Center, used photometric data from the NASA Kepler space telescope, which monitors the brightness of 155,000 stars. Earth-size planets whose orbital planes are aligned such that they periodically pass in front of their stars result in tiny dimmings of their host star's light, which can only be measured by a highly specialized space telescope like Kepler.

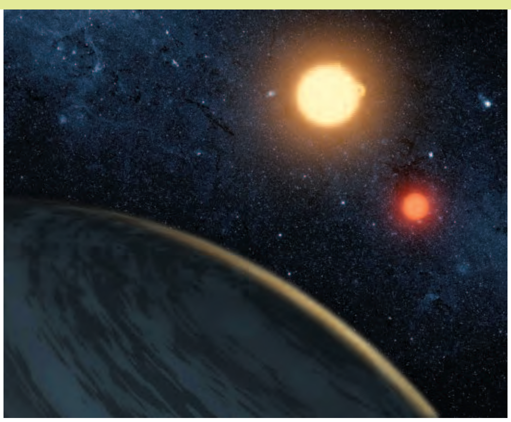
Images courtesy NASA/Ames/JPL-Caltech

The host star lies about 600 light-years away from us toward the constellations of Lyra and Cygnus. The star, a G5 star, has a mass and a radius only slightly smaller than that of our Sun, a G2 star and is about 25% less luminous than the Sun. The planet orbits the G5 star with an orbital period of 290 days, compared with 365 days for the Earth, at a distance about 15% closer to its star than the Earth is from the Sun. This gives the planet its balmy temperature. It orbits in the middle of the star's habitable zone, which is where liquid water is expected to be able to exist on the surface of the planet. Liquid water is necessary for life as we know it, and this new planet might well be not only habitable but perhaps even inhabited.

Numerous large, massive gas giant planets have been detected previously in habitable-zone orbits around solar-type stars, but gas giants are not thought to be capable of supporting life. This new exoplanet is the smallest-radius planet discovered in the habitable zone of any star to date. It is about 2.4 times larger than the Earth, putting it in the class of exoplanets known as super-Earths.

While the mass of this new planet is not known, it must be less than about 36 times that of the Earth, based on the absence of a measurable Doppler (radial velocity) wobble in the host star. The masses of several other super-Earths have been measured with the Doppler technique and determined to lie in the range of about five to 10 times that of the Earth. Some appear to be rocky, while others probably contain major fractions of ice and water. But none of these planets is in the habitable zone.

"This discovery supports the growing belief that we live in a universe crowded with life," Boss said. "Kepler is on the verge of determining the actual abundance of habitable, Earth-like planets in our galaxy."



Tatooine-like Planet Discovered

Boss was also part of a team that found the first planet to orbit two suns, as in the *Star Wars* film series. This discovery is the first direct evidence of a so-called circumbinary planet. A few other planets have been suspected of orbiting around both members of a dual-star system, but no previous transits of a circumbinary planet have been detected.

The team, led by Laurance Doyle of the Carl Sagan Center for the Study of Life in the Universe at the SETI Institute, also used photometric data from the NASA Kepler space telescope. The astronomers found the binary star system by detecting a system where the stars eclipsed each other from the perspective of the Kepler spacecraft. These stars have two eclipses: a primary eclipse, in which the larger star is partly blocked by the smaller star, and a secondary eclipse, in which the smaller star is fully blocked by the larger star.

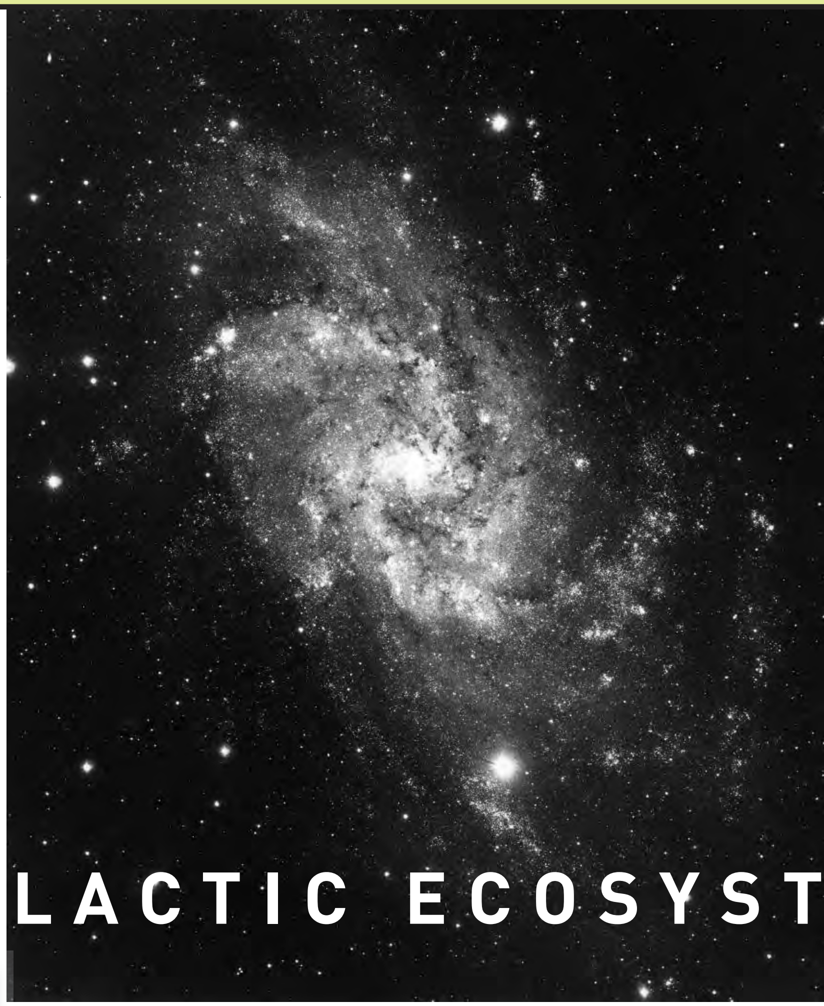
But the researchers also noticed other times when the brightness of the two stars dropped, even when they were not in an eclipse position. This pattern suggested that there was likely a third object involved. The fact that these so-called tertiary and quaternary eclipses recurred after varying intervals of time, and were of different depths, indicated that the stars were in different positions in their orbit at each instance. This result showed that the tertiary and quaternary eclipses were being caused by something circling both stars, and not an object circling one or the other star.

Measurements of the variations in the timing of all four types of eclipses, resulting from the mutual gravitational interactions of the two stars and the third body, demonstrated that the third object was, indeed, a planet. Their work indicates that the planet is less massive than Jupiter, possibly comparable in mass to Saturn, and that the larger of the two binary stars is smaller than our Sun.

"This discovery is stunning," Boss said. "Once again, what used to be science fiction has turned into reality." The findings were published in *Science.* □

Funding for the Kepler Discovery mission was provided by NASA's Science Mission Directorate. Some of the data used were obtained at the W. M. Keck Observatory, which is operated as a scientific partnership between the California Institute of Technology, the University of California, and NASA. The Keck Observatory was made possible with the support of the W. M. Keck Foundation.

Image courtesy NASA/Michael Rauch



This image, from the Hubble Space Telescope archive, reveals a galaxy that is highly distorted, with extended stellar tails to the left and right. The distortion appears to be from a collision with another galaxy.

Michael Rauch (below) is a staff astronomer at the Observatories.

GALACTIC ECOSYSTEM

A team of scientists led by Michael Rauch from the Carnegie Observatories has discovered a distant galaxy that may help us understand how galaxies take in matter and how they give off energetic radiation.

During the epoch when the first galaxies formed, it is believed that they radiated energy, which hit surrounding neutral hydrogen atoms and excited them to the point that they were stripped of electrons. This produced an ionized plasma that today fills the universe. But little is known about how this high-energy light was able to escape from the immediate surroundings of a galaxy. The galaxies we observe today tend to be completely surrounded by gaseous halos of neutral hydrogen, which absorb all light capable of ionizing hydrogen before it has a chance to escape.

Rauch and his team, using the Magellan telescopes at Las Campanas Observatory and archival images from the Hubble Space Telescope, discovered a galaxy with an extended patch of light surrounding it. The object's appearance means that roughly half of the galaxy's radiation must be escaping and exciting hydrogen atoms outside of its halo.

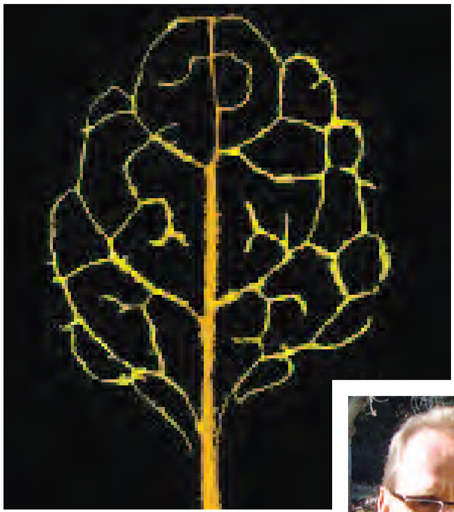
The key to the escape of radiation can be found in the unusual, distorted shape of the newly observed galaxy. It appears that the object had recently been hit by another galaxy, creating a hole in its halo, allowing radiation to pass through.

"The loss of radiation during galactic interactions and collisions like the one seen here may be able to account for the reionization of the universe," Rauch said. "This galaxy is a leftover from a population of once-numerous dwarf galaxies. And looking back to a time when the universe was more dense, crashes between galaxies would have been much more common than today."

The new observation also helps scientists better understand the flow of inbound matter from which a galaxy originally forms. In the present case, the escaping ionizing radiation illuminated a long train of incoming gas, which is feeding new matter into the galaxy. The existence of such structures had been predicted by theory, but they had not been seen previously because they barely emit any light of their own. □

The work, published in the *Monthly Notices of the Royal Astronomical Society,* had the following coauthors: George Becker and Martin Haehnelt from the Kavli Institute for Cosmology at Cambridge University, Jean-Rene Gauthier from the Kavli Institute for Cosmological Physics at the University of Chicago, Swara Ravindranath from the Inter-University Centre for Astronomy and Astrophysics, and Wallace Sargent from the Palomar Observatory at the California Institute of Technology.

THE PLANT PUMP



The image above shows the localization of the identified protein in the molecular pump in the vasculature of a plant leaf.

(Right) Wolf Frommer, leader of the study, is the director of Carnegie's Department of Plant Biology.

FOOD PRICES ARE SOARING at the same time that the population is exploding; thus the need for increased crop yields is becoming more and more important. New research led by Carnegie's Wolf Frommer identified a missing link responsible for moving sugar from the leaves of crop plants to harvested portions and other parts—a finding that could be crucial for addressing the food problem. The work was published December 8, 2011, in *Science Express.*

Plants do not have a heartlike pump to move their vital energy sources around. Instead, they use a molecular pump. Twenty years ago the Frommer team identified one of the key components of this molecular pump, which actively loads a sugar called sucrose into the plant's veins, a tissue called phloem. But how sucrose produced in the leaves via photosynthesis is delivered to the transporters that move it into the phloem has remained a mystery. Thus, a critical piece of the molecular pump was unknown—the protein that moves the sucrose into position inside the leaf cell wall, so the second, earlier-discovered component can transport it into the phloem.

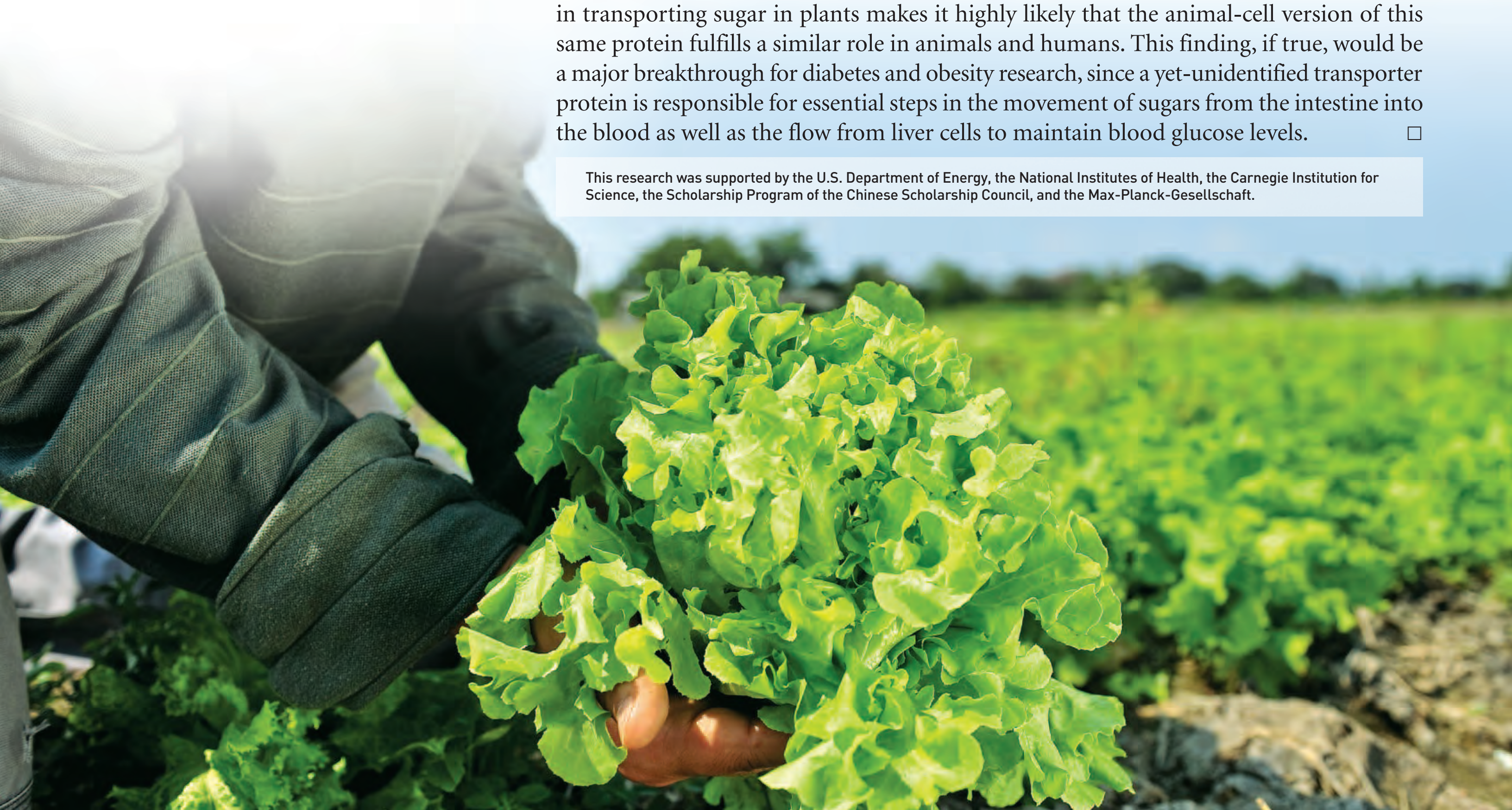
Frommer's team included Carnegie's Li-Qing Chen, the paper's lead author, Xiao-Qing Qu, Bi-Huei Hou, and Davide Sosso, as well as Sonia Osorio and Alisdair Fernie of the Max Planck Institute of Molecular Plant Physiology. In this new research, the team identified the missing piece of the molecular pump system.

"Like engineers, we can now fine-tune the pump components to address one of the major challenges for our future—namely, to increase the translocation of sugars toward seeds to increase crop yield," Frommer said. "The identification of these critical transporters is a major step toward developing strategies to ensure food supplies and keep food prices in check."

Additionally, pests abuse these transporters and use them to gain access to the plant's sucrose pools. Understanding 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.

The identification of the function of this missing piece of the molecular pump involved in transporting sugar in plants makes it highly likely that the animal-cell version of this same protein fulfills a similar role in animals and humans. This finding, if true, would be a major breakthrough for diabetes and obesity research, since a yet-unidentified transporter protein is responsible for essential steps in the movement of sugars from the intestine into the blood as well as the flow from liver cells to maintain blood glucose levels. □

This research was supported by the U.S. Department of Energy, the National Institutes of Health, the Carnegie Institution for Science, the Scholarship Program of the Chinese Scholarship Council, and the Max-Planck-Gesellschaft.



History Uncovered at Plant Biology

by WINSLOW BRIGGS and JAN BROWN

Stacy French (right) attended a meeting in Gatlinburg, Tennessee, in 1970. French invented the French pressure cell, which was used to study cellular structure and processes in plants. French's biophysical approach to the work was a major innovation.

Images courtesy Jan Brown

Plant Biology staff member Jens Clausen was a renowned pioneer in evolutionary and ecological genetics.

THE YEAR BEFORE staff member Jan Brown retired from the Department of Plant Biology in 1987, she put more than 600 Kodachrome slides, which she had taken between 1962 and 1982, into three metal boxes and created a computer file to catalog them. They were carefully put into storage, but after several years nobody—including the director who had stored them—could remember what had happened to them. They were then largely forgotten until the fall of 2010 when an archaeological investigation, in the guise of a thorough reorganization of the basement vault, uncovered the boxes.

Perhaps that long storage period was fortuitous. During the interim, the quality of computer scanning vastly improved. Nearly 500 slides were carefully sorted and culled down to a group of 400. These 400 were then professionally scanned and yielded fair to excellent photos that could be now be enhanced with Photoshop—especially helpful for faded Kodachromes.

A large number of the slides are of former department fellows, but the collection also includes many of the senior visitors who made shorter visits to the department during those years. In addition, Brown frequently snapped photos of colleagues and major figures in photosynthesis and plant physiology at the various scientific meetings and labs she visited. Finally, the photos include most of the employees—both scientific staff and support personnel—at the department during that 20-year period, as well as several visitors from Carnegie's administration. The plan is to make this archive available to anyone who is interested. □

The Face-off with Carbon

Image courtesy Anna Michalak

Global Ecology's Anna Michalak was a lead author of the plan.

RESEARCHERS HAVE LEARNED a lot about the carbon cycle in the last decade, but there is a lot more to do. A group of scientists, including Global Ecology's Anna Michalak, have developed a new, integrated, 10-year science plan to better understand the carbon cycle and the role of humans in it.

The first carbon science plan for the U.S., published in 1999, resulted in numerous breakthroughs for understanding the carbon cycle and how it is changing in response to human pressures. For instance, researchers discovered that the huge quantities of CO_2 absorbed by the oceans are causing ocean acidification, which is harming sea life and affecting the food chain. Research also characterized the large uptake of carbon by plants and soils in the Northern Hemisphere, and found that understanding land use and disturbance patterns is integral to understanding the global carbon cycle.

The new plan identifies new research areas such as the role of humans as agents and managers of carbon cycling and climate change, the direct impact of greenhouse gases on ecosystems, including changes in the diversity of plants and animals, ocean acidification, the need to address social concerns, and how best to communicate scientific results to the public and decision makers. The new plan is the culmination of a three-year effort with input from hundreds of scientists about the current needs of the research community.

The team developed four science elements to drive the research. The backbone of the strategy is to strengthen the network of observations to better monitor and track carbon as it winds its way through the atmosphere, ecosystems, oceans, and society, and to find out how this journey changes over time. Other elements include studies of the processes that control the flows and transformations of carbon, and the development of numerical models to predict future behavior.

Another important aspect of the plan is its increased emphasis on communication and making research more accessible to policy makers and the general public. It is hoped that this will lead to rational and well-informed decisions on how best to manage the global carbon cycle, especially the human impacts on it. □

The report, *A U.S. Carbon Cycle Science Plan*, was published by the University Corporation for Atmospheric Research supported by NASA, DOE, USDA, USGS, NOAA, NSF, and NIST. Global Ecology's Anna Michalak, Duke University's Rob Jackson, Appalachian State University's Gregg Marland, and the National Oceanic and Atmospheric Administration's Christopher Sabine led the work.

InBrief

❶ **From left to right, Yale University president Richard Levin, Carnegie Medal recipient Fred Kavli, and Carnegie president Richard A. Meserve pose for a photo at the Carnegie Medal event.**

Image courtesy Carnegie Corporation of New York

❷ Marnie Halpern

❷ Abi Subedi

❸ Youngjo Kim

TRUSTEES AND ADMINISTRATION

❶ Carnegie president **Richard A. Meserve** attended a meeting of the Council of the American Academy of Arts and Sciences on Sept. 30-Oct. 1 and participated in meetings of the Harvard Board of Overseers on Oct. 1-2, Dec. 3-4, and Feb. 3-5. He spoke at the Bipartisan Policy Center Nonproliferation Workshop in Washington, DC, on Oct. 3, participated in a meeting of the visiting committee to the MIT Nuclear Science and Engineering Dept. Oct. 4-5, and spoke at a meeting of the MIT Research Initiative on Oct. 6. He participated in the ceremonies for the award of the Carnegie Medal of Philanthropy in New York City on Oct. 20. He cochaired a meeting of the National Academies' Committee on Science, Technology, and Law in Washington, DC, on Oct. 24-25. He participated in a panel at the opening plenary session of the American Nuclear Society Winter Meeting in Washington, DC, on Oct. 31. He spoke at a symposium on nuclear power in Japan hosted by the Japan Science and Technology Agency in Tokyo on Nov. 7. He chaired a meeting of the IAEA's International Nuclear Safety Group in Vienna, Austria, on Nov. 9-11. He participated in a board meeting of Carnegie Canada in Montreal on Nov. 21 with board member **William Turner**. He participated in meetings of the Blue Ribbon Commission on America's Nuclear Future in Washington, DC, on Dec. 2 and Jan. 4. He traveled to Tucson for the casting of the second mirror for the Giant Magellan Telescope on Jan. 14. Meserve participated in council meetings of the National Academy of Engineering on Feb. 8-9. He served on a panel of international advisory experts to the Investigation Committee on the Accident of the Fukushima Nuclear Power Station in Tokyo on Feb. 23-25 and then testified before a similar committee chartered by the Japanese Diet on Feb. 27.

Carnegie president Richard A. Meserve was elected a Foreign Member of the Russian Academy of Sciences in Jan. He has engaged in extensive activities with the Russian Academy over the years on projects undertaken by the U.S. National Academies of Sciences and Engineering. He was elected in the section covering radiation safety, energy development, and environmental protection. The Russian Academy has approximately 250 Foreign Members.

On Feb. 8 the Federation of American Scientists presented Meserve with the inaugural 2011 Richard L. Garwin Award for "his distinguished service and significant contributions to nuclear safety as chairman of the Nuclear Regulatory Commission, and for more than 30 years of leadership in science policy." The award "reaffirms his work at the intersection of law, science, and technology." □

Carnegie president Richard A. Meserve was asked by the Japanese government to advise two of the commissions that were formed to investigate the Japanese Fukushima nuclear accident. He is among those in this group at the plant wearing protective gear. The Prime Minister formed the commission chaired by Dr. Yotaro Hatamura and the Japanese Diet formed the commission chaired by Kiyoshi Kurowawa. Meserve toured Fukushima and then spent several days in consultation with each of the commissions. He also interacted with several members of the Japanese Diet and with the Minister for the Environment, Goshi Hosono. He had previously met with Hosono, who visited Carnegie to discuss the Japanese plans to create a new independent regulator. □

EMBRYOLOGY

Director **Allan Spradling** attended the Nov. 2011 Packard Meeting in Monterey, CA. He coorganized and presented work at the Cold Spring Harbor Stem Cell meeting, and presented his work at U. Texas-Austin and at MIT. He was also the invited speaker for the 2011 William J. Larsen lecture at U. Cincinnati.

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Joe Gall presented the 2011 Tracy M. Sonneborn Lecture at Indiana U., "Transcription during the Lampbrush Chromosome Stage of Oogenesis."

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❷ **Marnie Halpern** was recently elected to the board of directors of the Genetics Society of America. She gave seminars at U. Toronto and Temple U. in Philadelphia and in Nov. was a Meet-the-Expert speaker at the Society for Neuroscience Annual Meeting in Washington, DC. Graduate student **Abhignya Subedi** spoke at the Mid-Atlantic Regional Zebrafish Meeting in Dec.

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❸ **Yixian Zheng** attended the 2011 ASCB meeting along with lab members **Youngjo Kim** and **Shusheng Wang**. Kim presented his work at the "Nuclear Periphery" minisymposium. Graduate student **Katie McDole** gave an invited talk at the Mouse Molecular Genetics Wellcome Trust Meeting in England.

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Steve Farber presented the Simkins Lecture on "How Science Outreach Impacts Urban Science Education" on Oct. 24 at Longwood U. and spoke at St. Mary's College of Maryland as part of their natural science colloquium series. He also spoke to the TriBeta undergraduate biological honors society about his work and his career path as a scientist and educator.

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Alex Bortvin presented his work at the 2nd EMBO conference on "Meiosis" in Paestum, Italy.

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Nick Ingolia presented a talk, "Genome-Wide Profiling of Translation Initiation and Protein Synthesis," at the International Institute of Molecular and Cell Biology, Warsaw, Poland, in Sept. In Oct. he presented a seminar at North Carolina State U. in Raleigh.

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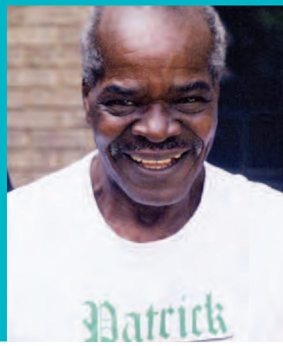
Arrivals: Postdoc **Matt Sieber** joined the Spradling lab, postdocs **Elim Hong** and **Troy Horn** joined the Halpern lab, and technician **Blake Caldwell** joined the Farber lab. The MacPherson lab welcomed technician **Michael Rongione**. Animal technician **Lauren Burkowske** joined the fish facility. The Bortvin lab welcomed research specialist **Ivana Celic**. Technicians **Hemi Ryu** and **Lynne Hugendubler** joined the Ingolia lab.

Microbes Everywhere!

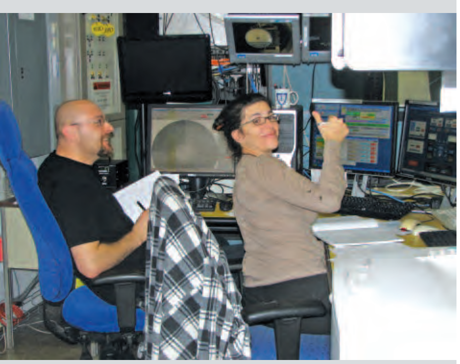
Every year Embryology postdoctoral fellows and graduate students organize a small meeting about a topic of interest. The 40th Carnegie Symposium on Oct. 27-28 was "Microbes—Invisible Partners in Health." The human body is host to diverse bacterial communities. Recent advances suggest that symbiotic microbes significantly influence development and physiology, which is not surprising given that there are more than 10 times more microbial cells in and on our body than there are human cells. Speakers talked about the composition and dynamics of microbial communities and their effect on the immune system, gastrointestinal tract, development, and disease. The organizers of the symposium were **Tagide deCarvalho**, **Lei Lei**, **Safia Malki**, and **Vanessa Matos-Cruz**. □



Lawrence (Pat) Patrick, a longtime employee at the Broad Branch Road (BBR) campus died in December. Pat worked at Carnegie for over 30 years, starting at GL then later joining the BBR engineering and maintenance department when the two departments colocated at BBR in May, 1990. Pat retired from the institution in 2002. ☐

❹ (Top) Marilyn Fogel in Belize. (Bottom) These mats in Belize are teaming with microbes, which can metabolize and recycle the small concentrations of available nitrogen and phosphorus.

Images courtesy Marilyn Fogel



❺ Tomasz Kolodziej and mentor Barbara Lavina

GEOPHYSICAL LABORATORY

Director **Russell J. Hemley** presented a plenary talk at the 23rd International Conference on High Pressure Science and Technology (AIRAPT-23) in Mumbai, India, Sept. 25-30, on "Single-Crystal Diamond: New Developments and Applications." In Oct. he gave a talk at the Advanced Diamond Science and Technology Meeting in Detroit. He also spoke at the International Conference Celebrating the 50th Anniversary of the Synthesis of Stishovite in Moscow on Nov. 10.

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Robert Hazen received the 2012 Virginia Outstanding Faculty Award, the highest such honor in Virginia. Hazen was introduced to the Virginia State Legislature on Feb. 16, prior to the awards ceremony in Richmond. He presented numerous invited lectures on mineral evolution, origins of life, and the Deep Carbon Observatory at Hampshire College, U. Massachusetts-Amherst, Montana State U., and at conferences in Italy, Korea, and San Francisco.

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Ho-kwang (Dave) Mao presented an invited talk at the China Academy of Engineering Physics, Mianyang, Sichuan, China, in Sept.

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Douglas Rumble helped to organize the 80th-birthday celebration for trustee and GL alumnus **W. Gary Ernst** at Stanford on Dec. 3-4. Ernst was a Carnegie Fellow from 1955 to 1957. Rumble presided at sessions held in honor of Ernst at the AGU meeting in San Francisco Dec. 5. On Dec. 12 Rumble served as rapporteur on the examining board for the thesis defense of Matthieu Galvez at the École Normal Supérieure de Paris.

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The Year 9 Carnegie/DOE Alliance Center (CDAC) Review took place on Oct. 25 at the Advanced Photon Source, Argonne National Laboratory. Talks were given by Carnegie's **Russell Hemley**, **Stephen Gramsch**, **Ho-kwang Mao**, **Guoyin Shen**, and **Wenge Yang**.

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❹ **Marilyn Fogel**, David Baker, and predoctoral fellow **Derek Smith** visited the Smithsonian Research Station on Carrie Bow Cay in Belize for two weeks. Smith studied microbial mats in mangroves on cays along the barrier reef. The water column is depleted in nitrogen and phosphorus, but the microbial communities thrive because they are able to metabolize and recycle the nitrogen and phosphorus, enabling dense mat communities. This serves as an analog to early Earth conditions when nutrients were in very low concentrations, but microbes were able to colonize and diversify. In addition, Smith presented a talk at the James Scott Memorial Session of the Fall AGU Meeting in San Francisco.

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On Nov. 7 research scientist **Jinfu Shu** gave a talk at the School of Physics, Astronomy and Computational Sciences, George Mason U. The talk title was "High Temperature (HT) and High Pressure (HP) Research with Diamond-Anvil Cell (DAC) by Synchrotron Light Source (SLS)."

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High Pressure Collaborative Access Team (HPCAT)

Beamline scientist **Stanislav Sinogeikin** attended the Goldsmith 2011 conference in Prague in Aug. 2011. He organized and chaired the session "Advanced Study of the Physical Properties of the Mantle Materials, and Applications to the Earth's Structure, Composition, and Dynamics." He also presented the talk and presented a poster at the APS 2011 user meeting.

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❺ **Tomasz Kolodziej** from AGH U. Science and Technology in Poland, supported by U. Nevada-Las Vegas and mentored by Barbara Lavina, HiPSEC and Dept. of Physics and Astronomy, arrived at HPCAT Sept. 30 and left Nov. 30. He studied the properties of the new high-pressure iron oxide, Fe_4O_5.

GLOBAL ECOLOGY

❻ **Chris Field** spoke at the 7th annual meeting of the Global Climate and Energy Project at Stanford. Alum **David Lobell**, also in attendance, moderated a session.

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Ben Kravitz, **Julia Pongratz**, **Long Cao**, **Ken Caldeira**, **Chris Field**, **Kris Ebi**, **Kyla Dahlin**, **William Anderegg**, **Rebecca Hernandez**, **Jennifer Johnson**, **Amelia Wolf**, **Naupaka Zimmerman**, **Lee Love-Anderegg**, **Joe Berry**, **Ted Raab**, **Michael Mastrandrea**, and **Katharine Mach** all presented talks or posters at the American Geophysical Union (AGU) meeting in San Francisco on Dec. 5-9.

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Julia Pongratz gave two invited talks at the iLEAPS conference in Garmisch, Germany, in Sept. She has also been awarded the AGU Editors' Citation for excellence in refereeing for reviews of geophysics.

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❼ **Ken Caldeira** appeared on the *PBS NewsHour* on Dec. 5 to describe the development of tethered kites designed to harness wind energy.

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Kenny Schneider, **Kate Ricke**, **Julia Pongratz**, **Ben Kravitz**, and **Ken Caldeira** participated in a field expedition to One Tree Island, Australia, where they conducted experiments to detect the influence of ocean acidification on coral reefs. Kenny Schneider and Ben Kravitz also performed experiments involving sea cucumbers grown under high-CO_2 conditions. The group made a number of YouTube videos of this expedition, which are available at http://www.youtube.com/user/CarnegieGlobEcology/.

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A paper published on climate-induced aspen forest die-off written by **William Anderegg** (with Joe Berry and Chris Field as coauthors) was on the cover of the *Proceedings of the National Academy of Sciences*. See page 9.

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Postdoc **Joseph Mascaro** joined journalist and author Emma Marris, chief scientist of the Nature Conservancy Peter Kareiva, and Carnegie alumnus **Erle Ellis** in a defense of the Anthropocene concept on the Dec. 8, 2011, op-ed page of the *New York Times*.

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Arrivals: Monalisa Chatterjee joined Chris Field's lab as a postdoc and **Patricia Mastrandrea** joined it as a temporary worker. The Caldeira lab welcomed postdocs **Kate Ricke**, who finished her Ph.D. at Carnegie Mellon U., **Ben Kravitz**, a Ph.D. from Rutgers U., and **Katherine Marvel**. Carnegie Fellow **Mark Higgins** from Duke U. is the newest member of the Asner lab as of Oct. 3. **Jessica Reilly** and **Gabriela Meckler** joined the Asner lab as interns in Nov.; **Eric Slessarev** became an intern in Joe Berry's lab on Dec. 1.

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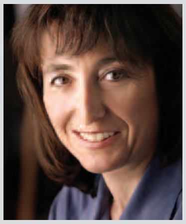
Departures: A send-off party was held for **Larry Giles**, who ran the mass spectrometer facility for the past 11 years, on Nov. 30. He is moving back to Durham, NC, where he is setting up a business, Bryotronics Research, with his own mass spectrometer. **Jan Brown** entered her second retirement at the end of 2011 after 50 years of working for Carnegie. She started at Plant Biology, retired in 1987, and returned as a volunteer editor in 2002. **James Jacobson** left the Asner lab on Nov. 18 for NASA Ames.

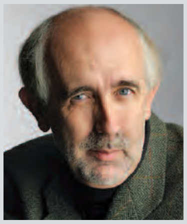
❻ Chris Field

❼ Ken Caldeira



❽ Wendy Freedman

❾ Luis Ho



❿ Barry Madore

⓫ Josh Simons

⓬ Wolf Frommer (right, sitting on wall) with his lab members

THE OBSERVATORIES

❽ On Oct. 17-18 **Wendy Freedman** participated in the GMT Exoplanet Workshop at the Harvard-Smithsonian Center for Astrophysics. On Oct. 28 she presented "Results from the Carnegie Hubble Project" at the Carnegie Science Day in Pasadena, CA. She gave an invited colloquium at UCLA on Nov. 9. She also gave the introduction to the GMT on Nov. 20 at the event "A Night on the Giant Magellan Telescope" hosted by U. Chicago alumni association in Los Angeles.

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❾ Staff astronomer **Luis Ho** organized the Carnegie Science Day in Nov. He gave a colloquium at UC-Riverside and invited talks at the Institute of High-Energy Physics, Chinese Academy of Sciences, in Beijing.

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❿ In Dec. senior research associate **Barry Madore** gave the seminar "What Is This Thing Called the Schmidt Law?" at Boston U. He also presented a colloquium at NRAO in Charlottesville, VA.

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⓫ Staff astronomer **Joshua Simon** gave a talk at the event "A Night on the Giant Magellan Telescope" hosted by U. Chicago alumni association in Los Angeles Nov. 20.

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Postdoctoral research associate **Nimish Hathi** was invited to serve on a Normal Galaxies panel for the NASA Astrophysics Data Analysis Program (ADAP) proposal review in Aug. 2011. He gave a talk in Sept. 2011 at the "Young and Bright: Understanding High Redshift Structures" conference in Potsdam, Germany, and was awarded the American Astronomical Society International Travel Grant to attend.

PLANT BIOLOGY

⓬ **Wolf Frommer** spoke at the GARNET Annual Meeting at Murray College, Cambridge, UK, on Sept. 6-7. On Sept. 8-9 he gave a talk at U. Düesseldorf on "Fluorescent Biosensors," and on Sept. 12-13 he attended the Association of Independent Plant Research Institutes (AIPI) meeting in St. Louis and talked about the role of sugar. On Sept. 22-24 he attended the Plant Science Summit held at HHMI in Chevy Chase, MD, and contributed a White Paper on "Technology to the Summit" with **David Ehrhardt**, a member of the writing committee. On Sept. 28-29 Frommer attended the NSF meeting on protein phosphorylation and on Sept. 29-Oct. 1 he gave a talk at the Plant Protein Phosphorylation Workshop held in Lake Tahoe, NV. On Oct. 18-19 Frommer gave a talk at U. North Texas-Denton about fluorescent biosensors, and on Oct. 20 he presented the same talk as the invited seminar speaker at the Samuel Roberts Noble Foundation in Ardmore, OK. He gave another biosensors talk at the Plant Gene Expression Center in Albany, CA, on Nov. 3. On Nov. 6-9 he presented a poster at the Grantees Workshop DOE in Baltimore, MD.

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On Aug. 30 **Zhiyong Wang** presented the talk "The Brassinosteroid Signaling Network: From Receptor Kinasis to Transcription Network" at the 57th Brazilian Congress on Genetics in Sao Paulo. He also spoke at the Phosphorylation Workshop held Sept. 30 in Tahoe City, NV. On Oct. 28 he was the invited seminar speaker at UC-Davis on brassinosteroids. He also gave a seminar at the Plant Science Center, RIKEN, Yokohama, on Nov. 7. He spoke at the 3rd International Symposium on Frontier in Agriculture Proteome Research, Tsukuba, Japan, on Nov. 9. He gave the plenary talk at the Plant Biotechnology Conference, Fuzhou, China, on Nov. 19.

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Kathy Barton attended the meeting of the Association of Independent Plant Research Institutes (AIPI) in St. Louis and also gave a talk, "Generation of a Deletion Mutant Resource OR How to Occupy Negative Space," at the "Plant Genomes & Biotechnology: From Genes to Networks" meeting on Nov. 30-Dec. 3 at Cold Spring Harbor Laboratory, NY.

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Matt Evans gave a talk at the Sept. 6-9 meeting "The Science of Gene Flow in Agriculture and Its Role in Coexistence" in Washington, DC.

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Tanya Berardini and **Donghui Li**, curators in the TAIR group, attended the Gene Ontology Consortium Meeting and Ontology Development Meeting Nov. 7-11 in London.

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Postdoctoral fellow **Alexander Jones** gave a talk at the Sept. 28-29 NSF meeting on Plant Protein Phosphorylation held at Granlibakken, Lake Tahoe, NV.

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Kathryn Barton taught a freshman seminar on hunger for Stanford students. The course covers the neurophysiology of what makes us feel hungry, the state of food security in the world, world agriculture and food sources, plant pests and famines, eating disorders, the discovery of vitamins and their biochemistry, and the history of experimentation on starvation. This year the course also covered the famine in Somalia. Students used social media to highlight news on this tragedy, which has seen little coverage in traditional media. Barton is on the far right in this image of her class. □

Increasing Awareness for Plant Science

In early 2011 four institutions, the Donald Danforth Plant Science Center, the Samuel Roberts Nobel Foundation, Carnegie's Dept. of Plant Biology, and the Boyce Thompson Institution for Plant Research formed the Association of Independent Plant Research Institutes (AIPI), whose major objectives are to increase awareness of and support for plant science discovery at a national level and to foster collaborative activities involving the participating institutions. AIPI holds annual meetings to encourage the conception and promotion of collaborative research. The 2011 annual meeting was held Sept. 12-13 in St. Louis and was attended by all Plant Biology staff members. The initiative also provides seed funding for collaborative projects between the four institutions. □

⓭ Jessica Warren

⓮ John Chambers

⓯ Michael Crawford photographed the lava flow from Mt. Etna.

Image courtesy Michael Crawford

⓯ The DTM team installs a strainmeter near the Etna volcano.

Postdoctoral research associate **Lee Chae** gave a talk at the Plant Genome Evolution 2011 conference in Amsterdam.

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Sue Rhee gave a talk at the Plant Genome Evolution conference on Sept. 4-6 in Amsterdam. On Sept. 30-Oct. 4 she attended the 27th Asilomar Conference on Mass Spectrometry held in Pacific Grove, CA, and gave the talk "Reconstruction and Application of Plant Metabolic Networks."

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Martin Jonikas attended the Stanford CMB retreat on Sept. 18 and presented a talk, "Novel Genetic Tools to Transform Our Understanding of Photosynthesis." He also gave a talk at the Carnegie board of trustees meeting on Nov. 18 at the Dept. of Embryology titled "Changing the Pace of Photosynthesis Research by Doing 100,000 Experiments at Once."

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Postdoctoral research associate **Guido Grossmann** attended the ASCB meeting in Denver, CO, on Dec. 3-12 and presented a talk on "RootChip."

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⓭ Jessica Warren (formerly a DTM postdoc and currently an assistant professor in Stanford's Dept. of Geological and Environmental Sciences) is collaborating with Plant Biology on electron microscopy. Warren's lab is fitting the scanning electron microscope with an electron backscatter diffraction (EBSD) detector. EBSD capability will allow Warren to study the microanatomy of thin sections of rocks. These anatomical details can then be used to understand how the rocks formed.

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Arrivals: The Frommer lab welcomed visiting researcher **Yibing Hu** on Nov. 5 from Nanjing Agricultural U., China; visiting graduate student **Alejandro San Martin** from Centro de Estudios Cientificos (CECS), Valdivia, Chile, on Nov. 11; and on Dec. 11 visiting scholar **Shingo Kikuta** arrived from the Japan Society for the Promotion of Science. Carnegie Fellow **Cheng Hsun Ho** arrived on Nov. 16 from the Institute of Life Sciences, China, as did **Wei Chuan Kao**, a graduate student from Stenden U., Netherlands. Arriving from Temasek U., Singapore, to finish their graduate studies in the Dinneny lab were **Yu Geng** on Sept. 16 and **Rui Wu** on Nov. 1. Arriving from UC-Berkeley, **Alexandra Grote** joined the Bhaya lab as a lab technician on Sept. 12. The Rhee lab welcomed **Tam Tran** in Oct. as a lab technician. The Jonikas lab added postdoctoral research associate **Leif Palleson** from U. Illinois on Sept. 14.

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Departures: Departing interns were **Jarod Nixon** on Sept. 9, **Duncan Oja** on Oct. 15, **Rick Kim** on Dec. 15, and **Brandon Araki, Tara Chandran,** and **Hilary Vance** on Dec. 31. On Dec. 31 lab technician **Doriann Moss** left the Ehrhardt lab and lab technician **Sam Parsa** departed the Frommer lab to pursue graduate studies. Lab assistant **Sairupa Paduchuri** left the Rhee lab, and programmer **April Wensel** left the TAIR group to join a startup company. Graduate student **Rafael Arenhart** returned to Brazil on Nov. 30 to continue his studies.

TERRESTRIAL MAGNETISM

In Oct. **Lindy Elkins-Tanton** spoke at a Harvard U. workshop on "Water and Carbon Delivery to Terrestrial Planets: Primary and Late Accretion." In Jan. she presented that talk at the Carnegie Observatories and at UC-Santa Cruz. In Dec. she gave two talks at the American Geophysical Union (AGU) 2011 Fall Meeting.

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Sean Solomon organized and chaired special sessions on MESSENGER orbital observations of Mercury at the joint meeting of the Division for Planetary Sciences of the AAS and the European Planetary Science Congress in Nantes, France, in Oct. Solomon chaired the 24th meeting of the MESSENGER Science Team, in Annapolis, MD, in Nov. He gave five seminars on MESSENGER findings: at Boston College in Oct., the Naval Research Laboratory and the Philosophical Society of Washington in Nov., and the Geological Society of Washington, the Lunar and Planetary Institute in Houston, and U. Maryland, all in Jan. He also attended a meeting for the GRAIL Science Team in Irvine, CA, that month.

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In Oct. **Alan Boss** spoke at the Workshop on the Formation and Early Evolution of Very Low Mass Stars and Brown Dwarfs, held in Garching, Germany. Boss also chaired a meeting of the NASA Advisory Council's (NAC) Astrophysics Subcommittee (APS) at NASA HQ, and presented the APS Letter Report to a meeting of the NAC Science Committee at NASA later that same month. In Nov. he gave an invited talk at the Workshop on the Formation of the First Solids in the Solar System, held in Kauai, HI. In Dec. he chaired the opening sessions of the First Kepler Science Conference at the NASA Ames Research Center in Mountain View, CA. He also gave an invited talk about the formation of gas giant planets at the Workshop on Exploring Giant Planets on NIF: A New Generation of Condensed Matter, held at the Lawrence Livermore National Laboratory in Livermore, CA. Boss gave radio interviews about Kepler's first habitable-zone super-Earth around a Sun-like star for the Voice of America. In Jan. he gave an invited colloquium at the NASA Goddard Space Flight Center in Greenbelt, MD.

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⓮ In Dec. **John Chambers** gave a talk at James Madison U. in VA, "Stellar Elemental Abundances and Planet Formation."

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In Oct. **Larry Nittler** presented seminars at Argonne National Laboratory and U. Chicago. In Nov. he gave talks at the 6th Biennial Geochemical SIMS Workshop, in Honolulu, HI; at the Workshop on Formation of the First Solids in the Solar System, in Kauai, HI; and at the 11th International Symposium on Origin of Matter and Evolution of Galaxies, in Tokyo. He also gave a seminar at U. Maryland. In Dec. Nittler gave a talk at the workshop "Isotopes in Astrochemistry: An Interstellar Heritage for Solar System Materials?" in Leiden. He also gave a seminar at DTM that month.

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In Oct. **Scott Sheppard** gave a talk at the American Astronomical Society Division for Planetary Sciences meeting in Nantes, France. In Nov. he presented at the emergency meeting on collisional hazards around Pluto for the New Horizons mission to Pluto in Boulder, CO.

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In Oct. **Diana Roman** spent two weeks at Kilauea Volcano doing fieldwork at the Hawaiian Volcanoes Observatory. During that time she gave a colloquium talk and presented another colloquium talk that month at NASA Goddard. In Dec. Roman and her students presented four posters at the AGU Meeting.

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Former staff member Roy Britten, initially a physicist and then a pioneering molecular biologist, died on January 21 at the age of 92. He joined DTM in 1951 as a member of the biophysics group. He was interested in the fundamental organization and evolution of animal DNA. In 1971 he went to Caltech as a Distinguished Carnegie Senior Research Associate in molecular biology.

In 1954 Britten wrote to Merle Tuve, then DTM director, "I feel that the time I have spent here has been the most fruitful period of my life and I expect it to grow more fruitful."

Britten received his B.S. from the University of Virginia, his master's degree from The Johns Hopkins University (1940-1941), and his Ph.D. from Princeton in 1951. During the war, he worked with the mass spectrograph activities on the Manhattan Project. While at Hopkins he worked at the Bureau of Standards on isotope separations. □

⓰ Frank Press

⓰ Paul Silver

In Nov. **Matt Fouch** represented the Incorporated Research Institutions for Seismology (IRIS) and EarthScope communities at the National Science Foundation Large Facility recompetition panel. He also gave an invited talk at NASA Goddard Space Flight Center in Dec. Later that month, Fouch was elected to a three-year term as vice chair of the IRIS board of directors. He also gave two talks at the Fall AGU Meeting.

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Postdoctoral associate **Nicholas Moskovitz** gave a talk and presented a poster at the AAS Division of Planetary Sciences Meeting in Oct. In Nov. he visited the Johns Hopkins Center for Astrophysical Science and gave an invited colloquium, "Origin and Evolution of the Earliest Planetary Bodies in the Solar System." Also that month, he gave media interviews regarding the near-Earth flyby of asteroid 2005 YU55 to *Nature*, *Washington Post*, *Christian Science Monitor*, *Chemistry World*, and *US News and World Report*.

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⓰ Library technical assistant Merri Wolf processes recent donations of books from Frank Press and Nathalie Valette-Silver.

On Oct.18 a daylong symposium was held in honor of former director **Sean Solomon**. Twenty speakers recognized Solomon's role as director for 19 years and his significant scientific contributions. DTM staff scientists **Erik Hauri**, **Scott Sheppard, Matthew Fouch**, **John Chambers**, **Diana Roman**, **Paul Butler**, **Conel Alexander**, **Larry Nittler**, and **Alycia Weinberger** spoke about their current research. All hired by Solomon during his tenure, they explained his crucial role in inspiring their work and making their research a possibility. □

A daylong symposium and reception were held in Sean Solomon's honor as he stepped down from his directorship to become a staff scientist. He is shown at left at the reception in the Greenewalt Building.

In Oct. postdoctoral associate **Brian Jackson** spoke at the Annual Meeting of the Division of Planetary Sciences /European Planetary Science Congress. In Nov. he did fieldwork in Death Valley National Park on the Sailing Stones at Racetrack Playa.

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The 2012 Geological Society of America meeting was held Oct. 9-12 in Minneapolis. Presenters included **Matt Fouch**, **Christian Klimczak**, **Larry Nittler**, and **Sean Solomon**.

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⓯ In Oct. seismologists **Alan Linde** and **Selwyn Sacks**, along with **Brian Schleigh**, **Michael Acierno**, and **Michael Crawford**, captured on camera a spectacular lava fountain spewed by Mt. Etna, an active stratovolcano on the east coast of Sicily. The scientists were in Sicily to install 2 borehole strainmeters close to the volcano. They are working closely with Alessandro Bonaccorso and the Istituto Nazionale di Geofisica e Vulcanologia-Sezione di Catania-Osservatorio Etneo. The team expects the devices will detect crustal deformation due to the magma movement from such eruptions and help improve the understanding of magma movement.

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Sixteen staff scientists and postdoctoral fellows attended the 2011 American Geophysical Union Fall Meeting in San Francisco on 5-9: **Paul Byrne**, **Chin-Wu Chen**, director **Lindy Elkins-Tanton**, **Matt Fouch**, **David James**, **Christian Klimczak**, **Diana Roman**, **Selwyn Sacks**, **Steve Shirey**, **Debbie Smith**, **Sean Solomon**, **Daoyuan Sun**, **Fouad Tera**, **Liyan Tian**, **Shoshana Weider**, and visiting scientist **Cecily Wolfe.**

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Arrivals: Fukashi Maeno, an assistant professor at the Volcano Research Center of the Earthquake Research Institute at U. Tokyo, arrived in Oct. He worked with **Selwyn Sacks** and **Alan Linde** on the analysis of the Montserrat strainmeter data. In Nov. independent researcher **Stephanie Brown** visited DTM. Brown completed her master's at the Dept. of Earth, Atmospheric, and Planetary Sciences at MIT under the supervision of Elkins-Tanton.

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Senior Tuve Fellows **Emily Brodsky** and **Francis Nimmo** from UC-Santa Cruz and **Celal Sengor** from Istanbul Technical U. came for the month of Nov. They collaborated on MESSENGER with Sean Solomon and attended the 24th MESSENGER Science Team Meeting held in Annapolis, MD.

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Elkins-Tanton hosted four visitors in Dec.: **Danielle Piskorz**, **Karen Meech**, **Jonathan Wynn**, and **Benjamin Black** for three months to finish a project on the tectonics of Venus. Piskorz is a recent MIT graduate. Meech, from U. Hawaii Institution for Astronomy, presented a seminar, "Activity in Distant Comets and the Early Solar System." Wynn is a biogeochemist at U. South Florida studying stable isotope geochemistry, the global carbon cycle, paleoenvironments and paleoclimate, paleoclimatic forcing of human evolution, and the geological record of fossil soils. Black, a graduate student in the Earth, Atmosphere, and Planetary Sciences Department at MIT, is working on the Siberian Traps flood basalts with Elkins-Tanton and collaborating with Erik Hauri. In Dec. **Dave Bercovici**, professor and chair of the Dept. of Geology and Geophysics at Yale, spent two days at DTM to give a special seminar, "Generation of Plate Tectonics on Earth and Other Planets." Postdoctoral fellow **Kelsey Druken** joined DTM in Jan. She will be working with David James on the High Lava Plains experiment. In Jan. **Marcus Key** from Dickinson College and his student **Paige Hollenbeck** visited DTM to work with **Conel Alexander** and the geochemistry group.

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Departures: In Dec. postdoctoral associates **Guillem Anglada** relocated to U. Göttingen in Germany, **Chin-Wu Chen** joined National Taiwan U., and **Daoyuan Sun** left for U. of Southern California. In Jan. **Eloise Gallou** went to the Museum of Natural History in Los Angeles.

DTM/GL

Shaun Hardy attended the Geoscience Information Society's annual meeting in Minneapolis in Oct.

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⓰ **Frank Press**, former Cecil and Ida Green Senior Fellow at DTM and Geophysical Laboratory and trustee emeritus, donated 250 geoscience books and reports to the departments' joint library. The research files and professional correspondence of late DTM staff member **Paul G. Silver** were donated to the DTM archives by his wife, Nathalie Valette-Silver. The collection documents nearly three decades of Silver's pathbreaking research in seismology and geodynamics. Silver's extensive personal library of geophysics books and journals was donated to the Broad Branch Road campus library and several major universities. □

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