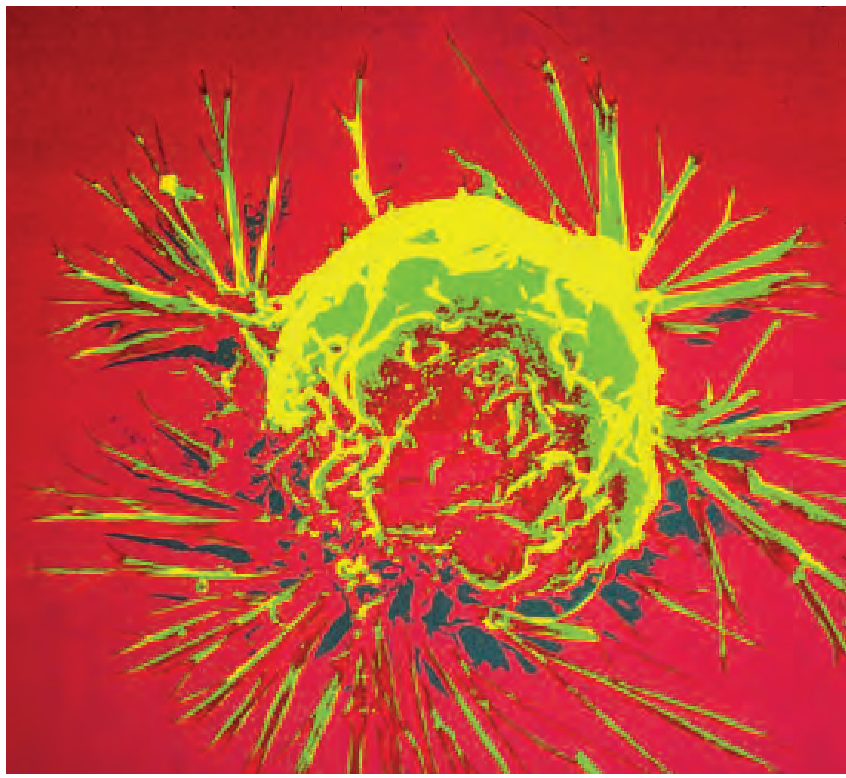
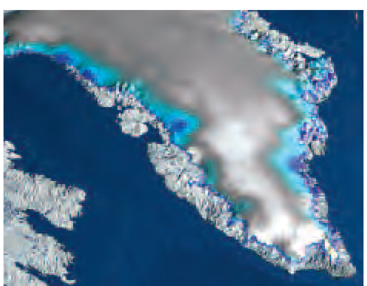
CarnegieScience

The Newsletter of the Carnegie Institution

SUMMER 2013

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

Thank You Mike Gellert!

Mike Gellert has served as the chairman of the Carnegie board for the last 10 years and as a board member for 18. At our recent board meeting, he turned over the helm to our new cochairs, Suzanne Nora Johnson and Steve Fodor. I write here to acknowledge that we are deeply appreciative of Mike and all he has done for the Carnegie Institution. Carnegie owes much of its current vitality to his decade of leadership.

Mike became chairman at the same time that I became president, and I have greatly benefitted from his counsel and wisdom. Moreover, the entire institution has advanced as a result of his philanthropy and guidance. He has helped all of our science and educational programs, and he has been pivotal in the resolution of a myriad of institutional issues that have arisen over the past decade. Carnegie has profited from the many insights Mike has offered as a member of various board committees and as chairman.

Mike demonstrates his commitment by his actions. He is among the first to make a pledge and the first to fulfill it. Only four others have surpassed him in giving over our entire history. Moreover, Mike has also actively encouraged philanthropy by others. Over the years, he has hosted numerous events and has traveled countless miles to help broaden the circle of Carnegie friends.

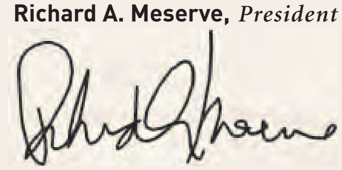
In addition to his exemplary philanthropy, Mike has engaged personally in the pursuit of several noteworthy projects. He was deeply involved with establishing the Department of Global Ecology, our newest department. With only five senior staff, Global Ecology has made revolutionary advances in studying ecosystems using the Carnegie Airborne Observatory (page 10-11), understanding ocean acidification, unraveling the causes of aquatic algal blooms, exploring the carbon and nitrogen cycles, and much more. The accomplishments of the department are nothing short of astonishing and amply demonstrate Mike's wisdom in advancing a department to confront vital environmental challenges.

During Mike's term, we were also able to complete a new building for the Department of Embryology on The Johns Hopkins University Homewood campus. It was essential to upgrade the facility and to provide cutting-edge microscopy and genomics facilities to remain at the forefront of cellular, developmental, and genetics biology. The facility is a model for others. Mike understands the necessity of high-quality infrastructure in the pursuit of significant scientific advances.

Mike is also committed to long-term projects, one of which is the Giant Magellan Telescope (GMT). In 2003, our astronomers advanced the dream of building a telescope that would dwarf anything previously built. Mike realized that the commitment would take many years to fulfill, and if we did not get started we would depart from our century-long legacy of pioneering telescope and instrumentation development. Like Andrew Carnegie, Mike knew that success would be measured long after he left the chairmanship of the Carnegie board. The GMT will explore some of the most tantalizing scientific questions that now confound us—the possible existence of life on other planets, the nature of dark energy and dark matter, and the structure of the universe.

We are indebted to Mike for his extraordinary, unselfish, and generous support. From all of us at Carnegie, thank you Mike!

Richard A. Meserve, *President*



Images courtesy Gediyon Kifle

Left: Carnegie president Richard Meserve (left) unveils the plaque naming the Michael E. Gellert Rotunda.

Below: Trustees and guests applaud Mike Gellert's (sitting) service to Carnegie as chairman of the board over the last decade.

Bottom: The Gellert family gathers in the rotunda that now bears Michael Gellert's name. From left to right: daughter Catherine Gellert, brother Martin Gellert, Martin's wife Jacqueline Michaud, wife Mary Gellert, Michael Gellert, daughter-in-law Samantha Gellert, and son John Gellert.

Trustee News

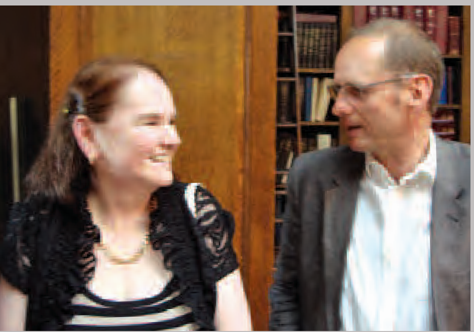
The board of trustees held their 138th meeting at the Washington, D.C., administration building on May 2nd and 3rd. Michael Gellert, chairman of the board for the last ten years, stepped down as chair. He remains an active member of the board and is succeeded by cochairs Suzanne Nora Johnson and Steve Fodor, who will share duties.

The Employee Affairs, Finance, and Development committees met on May 2nd, followed by the first session of the board. That evening trustees and guests attended a dinner in honor of Michael Gellert's service. During the dinner President Richard Meserve announced that the administration building's stunning rotunda would be named the Michael E. Gellert Rotunda.

Norman Augustine was the evening's speaker. He is the retired chairman and chief executive officer of Lockheed Martin Corporation and a longtime proponent for ensuring that science and engineering remains a national priority. He chaired the National Academy of Sciences commission that conducted a congressionally requested study that became the landmark report *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* released in 2005.

Augustine talked about the enormous impact of globalization and information technology on societies. "Distance is dead," he said. "America now has to compete for jobs with people across the planet." He then described the challenges the U.S. faces in this environment, stressing that innovation—particularly through research and development—is key to successful competition. Augustine talked about the reasons for the recent decline the U.S. has witnessed in science and technology education and how the U.S. now stacks up against the world, and he suggested some possible ways to change course.

The evening concluded with music by pianist and composer Hayk Arsenyan. The next day the Audit committee and second session of the board met. □



Kathi Bump (left) with Wolf Frommer

Steve Coley

Serving Science

Carnegie president Richard Meserve presented two Service to Science Awards for 2012 before the Carnegie Evening lecture on May 1. The award was created to recognize "outstanding and/or unique contributions to science by employees who work in Carnegie administration, support, and technical positions."

The first recipient of the 2012 award was Kathi Bump. Kathi started with the Department of Plant

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Biology in 1995 as an administrative assistant. She held various positions at the department until 2006, when she was named the business manager of the Plant Biology and Global Ecology departments that share space on the Stanford University campus. Kathi's level of dedication is legendary. She handles issues ranging from accounting, inventory, facilities, and the care of students and visitors to the proper functioning of the soda machine.

The second 2012 recipient was Steve Coley. Steve joined the Geophysical Laboratory as an instrument maker in 1983. He has provided essential support in developing and maintaining complex and highly specialized equipment at the Geophysical Laboratory. The instruments and equipment that Steve developed have been essential to the cutting-edge research and groundbreaking discoveries of the scientific staff at the Geophysical Lab. Due in large part to Steve's abilities, the facilities of the Geophysical Laboratory are exceptional among Earth and materials science laboratories around the world.

The panel that reviewed the nominations and selected the award recipients were Alan Dressler, staff scientist at the Observatories; Steve Farber, staff scientist at the Department of Embryology; and Cady Canapp, manager of human resources. □

Global Ecology's Greg Asner was this year's Carnegie Evening speaker.

Carnegie Evening: Asner's "Science Heart"

Greg Asner compared his work in the Global Ecology department to giving an ecosystem's landscape an MRI—using technology to determine its construction and components. Asner discussed his research in a talk titled "Exploring and Managing the Earth from the Sky" at the May Carnegie Evening lecture in Washington, D.C.

Asner's revolutionary technology combines laser and spectral instrumentation aboard a fixed-wing aircraft called the Carnegie Airborne Observatory (CAO). Researchers use this instrumentation to reveal an ecosystem's chemistry, structure, biomass, and biodiversity and create stunning 3-D maps. The technology allows surveys over extensive areas in a way not possible before.

"We had limited types of information about ecosystems; the Carnegie Airborne Observatory [is] designed to overcome that," Asner told the group. By using CAO's laser and spectral technology, "we can look at something from afar and understand, for example, its carbon content [and] its … nutrient content."

Most of Asner's talk focused on his work in the Amazon, which he said is "where my science heart lies." The region is thought to contain about half of all species on Earth and at least 100-billion tons of carbon. The team has completed maps of the entire carbon stocks of Peru, Colombia, and Panama. Activities are underway to map for the first time the biological diversity of the western Amazon region—a global hotspot for species diversity.

Unfortunately, land development for energy, food, and minerals is dismantling the Amazon basin. The Amazonian climate has also already begun to change, and species are migrating to survive.

"I'm trying to understand the system while it's changing, and it's changing in ways that aren't even the same year to year," Asner said. "There's so much going on and there's not one answer."

Using the CAO, the team is able to uncover illegal gold mining and palm oil holdings, which are negatively affecting the Amazon's ecosystem. They are also studying drought patterns in the wake of the 2010 Amazon megadrought.

Outside of the Amazon, CAO technology is being used to study wildlife, as well as plant life. Asner discussed exciting research in South Africa's Kruger National Park where their mapping has shed light on the hunting behavior of male lions, revealing that they aren't the slackers they've long been believed to be. Their hunting behavior is just less well-observed, because it takes place in dense vegetation "where nobody in their right mind is going to go. Believe me I've been there and I was not in my right mind," Asner joked. These results help park officials make decisions on managing the land to best protect the animals.

At the end of the talk, Asner said his goals for CAO include seeking out ecological frontiers that are still unknown and unappreciated, to support environmental decision making, and to teach and inspire. □

The Andrew Mellon Foundation, the Avatar Alliance Foundation, the Gordon and Betty Moore Foundation, the Grantham Foundation for the Protection of the Environment, the John D. and Catherine T. MacArthur Foundation, the Margaret A. Cargill Foundation, Mary Anne Nyburg Baker and G. Leonard Baker, Jr., the W. M. Keck Foundation, and William R. Hearst III helped make the Carnegie Airborne Observatory possible.

Gas Giants

Hard to Destroy

New theoretical modeling by Carnegie's Alan Boss provides clues as to how our Solar System's gas giant planets—Jupiter and Saturn—might have formed and evolved. *The Astrophysical Journal* published this work in March.

New stars are surrounded by rotating gas disks during the early stages of their lives. Gas giants are thought to form in the presence of these disks. Observations of young stars that still have these gas disks indicate that sun-like stars undergo periodic episodes—lasting about 100 years—that transfer mass from the disk onto the young star, increasing its luminosity. Researchers think that these short bursts of mass accretion are driven by marginal gravitational instability in the gas disk.

There are competing theories for how gas giant planets form around protosuns. One theory proposes that the planets form from slowly growing ice and rock cores, followed by rapid accretion of gas from the surrounding disk. The other theory proposes that clumps of dense gas form in spiral arms, increasing in mass and density, forming a gas giant planet in a single step.

Boss developed highly detailed 3-D models demonstrating that, regardless of how gas giants form, they should be able to survive periodic outbursts of mass transfer from the gas disk onto the young star.

One model similar to our Solar System was stable for more than 1,000 years, while another model containing planets similar to Jupiter and Saturn was stable for more than 3,800 years. The models showed that these planets were able to avoid being forced to migrate inward and be swallowed by the growing protosun or being tossed completely out of the planetary system by close encounters with each other.

Scientists have found extrasolar gas giant planets around about 20% of sun-like stars, which is a reassuring outcome. It suggests that our improved theoretical understanding of the formation and orbital evolution of gas giants is on the right track. □

Alan Boss

Image courtesy NASA

Alan Boss is developing theories about how gas giant planets like Jupiter formed and survived in the early days of our Solar System. Jupiter and its four planet-sized moons, the Galilean satellites, were photographed and assembled into a collage.

This research was supported in part by the NASA Origins of Solar Systems Program and contributed to in part by the NASA Astrobiology Institute. The calculations were performed on the Carnegie Alpha Cluster, the purchase of which was partially supported by an NSF Major Research Instrumentation grant.

Image courtesy John Chapman Wikimedia Commons

Spotlight on Molybdenite

Molybdenite (dark) is shown on quartz.

Robert Hazen

Mineral evolution is an approach to understanding Earth's ever-changing near-surface geochemistry. All chemical elements were present at the start of our Solar System, but at first the elements formed few minerals—perhaps no more than 500 different ones in the first billion years. As time passed, novel combinations of elements led to new minerals. A team led by Carnegie's Robert Hazen is conducting research with the mineral molybdenite, and their work provides important new insights about the changing chemistry of our planet as a result of geological and biological processes.

Robert Hazen's research shows that molybdenite distribution correlates with five periods of supercontinent formation, including that of Pangaea.

Image courtesy USGS

Molybdenite is the most common ore mineral of the critical metallic element molybdenum. Hazen and his team, which included fellow Geophysical Laboratory scientists Dimitri Sverjensky and John Armstrong, analyzed 442 molybdenite samples from 135 locations with ages ranging from 2.91 billion years old to 6.3 million years old. They specifically looked for trace contamination of the element rhenium in the molybdenite. Rhenium is a trace element that is sensitive to oxidation reactions (the transfer of electrons) and it can be used to gauge historical chemical reactions with oxygen from the environment.

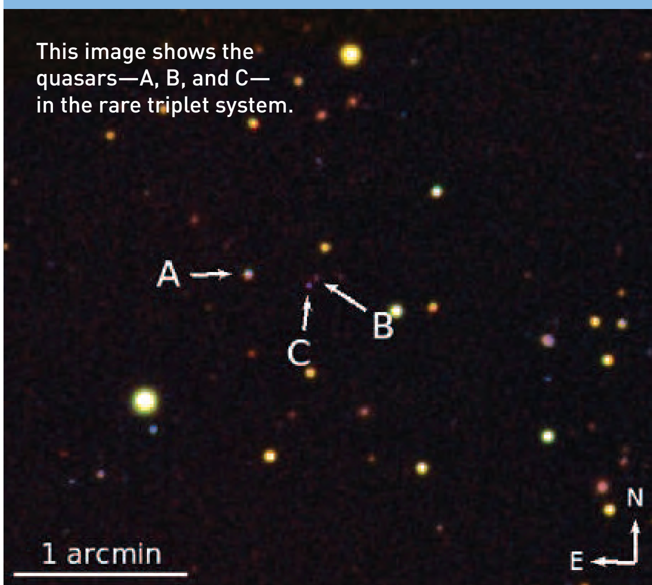
The team found that concentrations of rhenium increased significantly—by a factor of eight—over the past three billion years. They suggest that this change reflects the increasing near-surface oxidation conditions from the Archean eon beginning more than 2.5 billion years ago to the Phanerozoic eon less than 542 million years ago. This oxygen increase was a consequence of what's called the Great Oxidation Event, when the Earth's atmospheric oxygen levels skyrocketed as a consequence of the emergence of oxygen-producing photosynthetic microbes.

In addition, the team found that the distribution of molybdenite deposits through time roughly correlates with five periods of supercontinent formation: the assemblies of Kenorland, Nuna, Rodinia, Pannotia, and Pangaea. This correlation supports previous findings from Hazen and his colleagues that mineral formation increases markedly during episodes of continental convergence and supercontinent assembly and that a dearth of mineral deposits form during periods of tectonic stability.

Overall, this work further demonstrates that a major driving force for mineral evolution is hydrothermal activity associated with colliding continents and the increasing oxygen content of the atmosphere caused by the rise of life on Earth. *Earth and Planetary Science Letters* published this work in February. □

The Carnegie Institution for Science provided a grant to support the initial development of the Mineral Evolution Database. NASA Astrobiology Institute and the Deep Carbon Observatory, as well as an NSF-NASA collaborative research grant and DOE, supported this work in part.

Rare Triplet Quasar Discovered



This image shows the quasars—A, B, and C—in the rare triplet system.

Image courtesy Emanuele Paolo Farina

For only the second time in history, a team of scientists—including Hubble Carnegie/Princeton Fellow Michele Fumagalli—has discovered an extremely rare triple-quasar system. This rare phenomenon will help scientists understand how cosmic structures assemble in the universe and the basic processes by which massive galaxies form.

Quasars are extremely bright and powerful sources of energy that sit in the center of a galaxy; they surround a black hole. In systems with multiple quasars, the quasars are held together by gravity. They are believed to be the product of galaxies colliding.

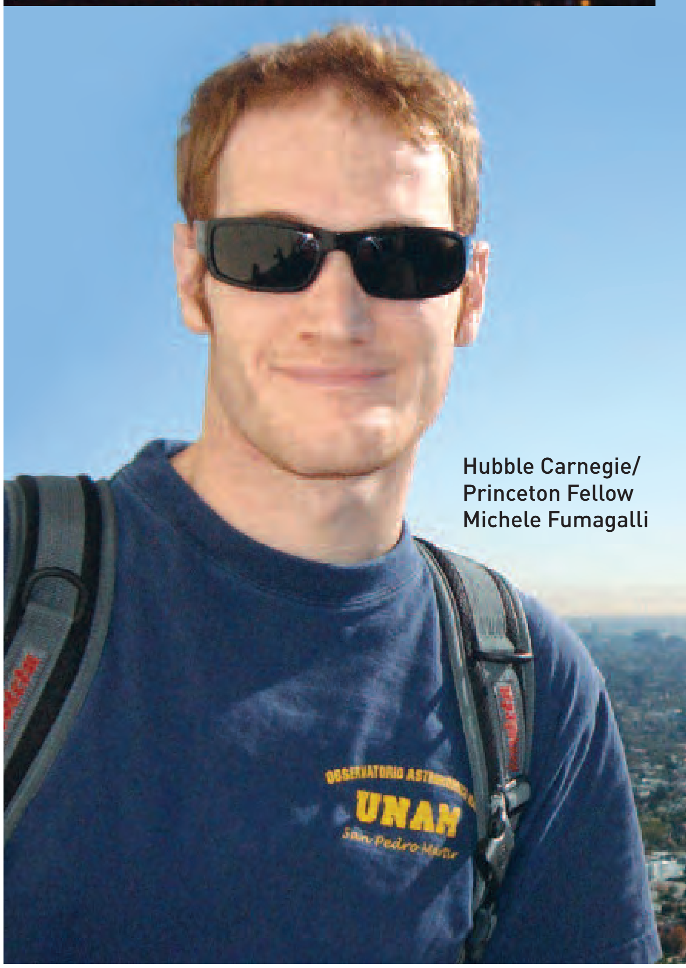
It is very difficult to observe triplet quasar systems because of observational limits that prevent researchers from differentiating multiple nearby bodies from one another at astronomical distances. Moreover, such phenomena are presumed to be very rare.

By combining multiple telescope observations and advanced modeling, the team found the triplet quasar named QQQ J1519+0627. The light from these quasars traveled 9 billion light-years to reach Earth, which means the light was emitted when the universe was only a third of its current age.

Advanced analysis confirmed that what the team found was indeed three distinct sources of quasar energy and that this phenomenon is extremely rare.

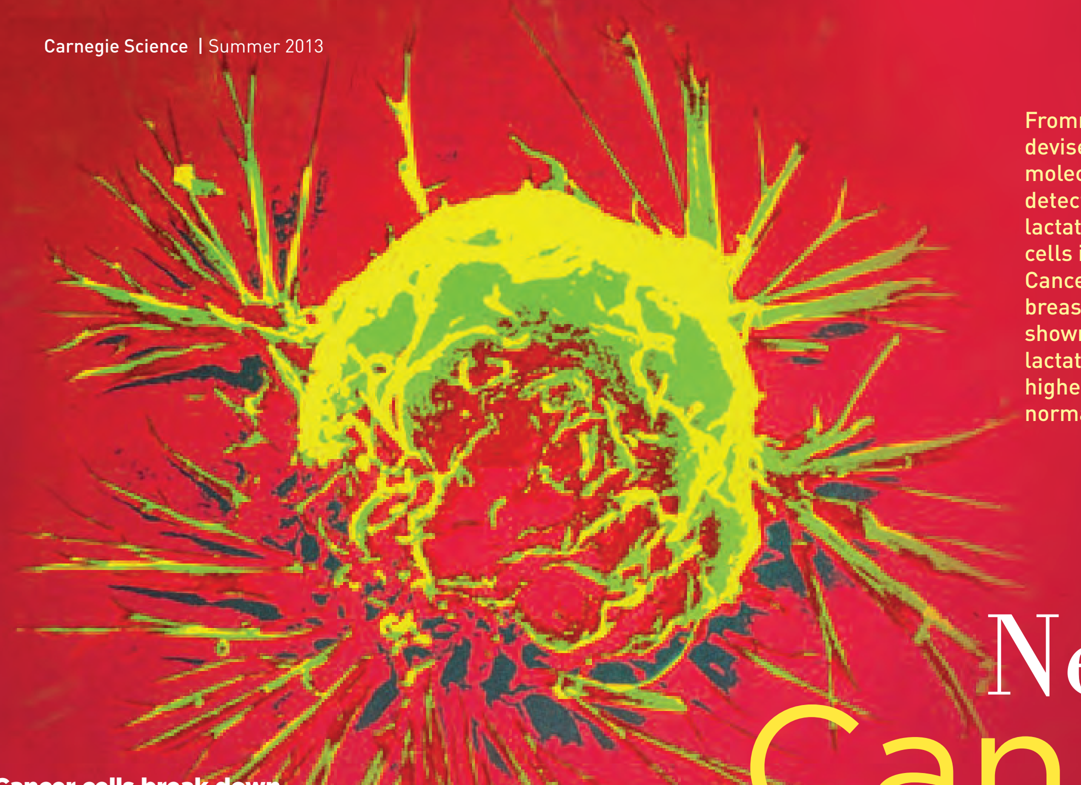
Two members of the triplet are closer to each other than the third. This means that the system could have been formed by interaction between the two adjacent quasars but was probably not triggered by interaction with the more-distant third quasar. Furthermore, researchers saw no evidence of any ultraluminous infrared galaxies, which is where quasars are commonly found. As a result, the team proposes that this triple-quasar system is part of some larger structure that is still undergoing formation. *Monthly Notices of the Royal Astronomical Society* published this work in March. □

This research was based on observations collected at the La Silla Observatory with the New Technology Telescope of the European Southern Observatory and at the Calar Alto Observatory with the 3.5 m telescope of the Centro Astronómico Hispano-Alemán. Societa Carlo Gavazzi S.pA., Thales Alenia Space S.pA., Germany's National Research Center for Aeronautics and Space, and NASA supported this work.



Hubble Carnegie/ Princeton Fellow Michele Fumagalli

Image courtesy Michele Fumagalli

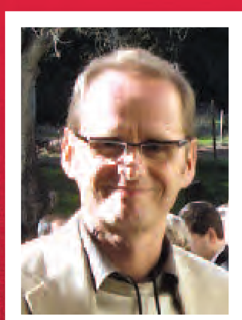


Frommer's team devised a new molecular sensor that detects levels of lactate in individual cells in real time. Cancer cells, like this breast cancer cell shown here, produce lactate at a much higher rate than normal cells.

Image courtesy Bruce Wetzel and Harry Schaefer, National Cancer Institute, NIH

New Cancer Diagnostic Technique

Cancer cells break down sugars and produce the metabolic acid lactate at a much higher rate than normal cells. This phenomenon provides a telltale sign that cancer is present and possibly offers an avenue for novel cancer therapies. Carnegie's Wolf Frommer worked with a team of Chilean scientists to devise a molecular sensor that detects levels of lactate in individual cells in real time. Prior to this advance, no other measurement method could noninvasively detect lactate in real time at the single-cell level.



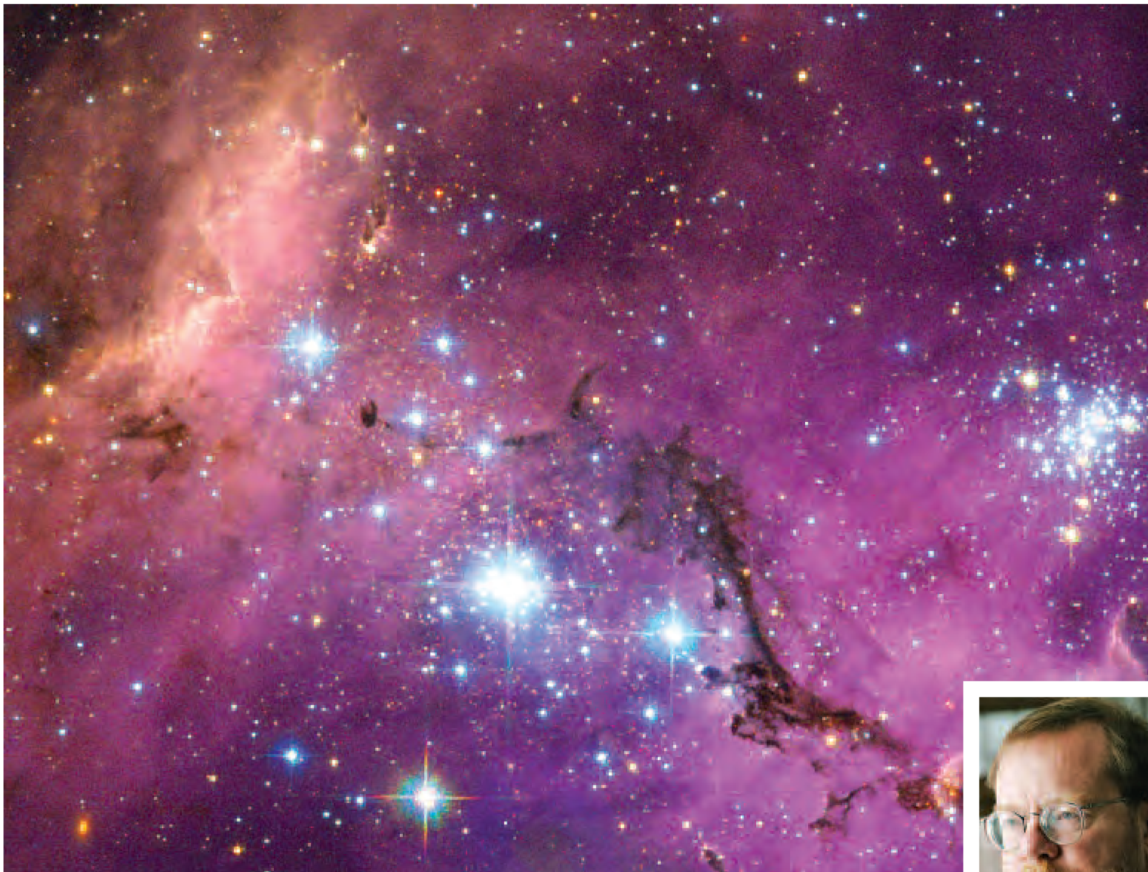
Plant Biology director Wolf Frommer

Over the last decade, the Frommer lab has pioneered the use of Förster resonance energy transfer (FRET) sensors to measure the concentration and flow of sugars in individual cells with a simple fluorescent color change, revolutionizing the study of cell metabolism. Using the same underlying physical principle and inspired by the sugar sensors, Frommer and the Chilean scientists invented a new type of sensor based on a transcription factor. A molecule that normally helps bacteria adapt to its environment has now been tricked into measuring lactate for researchers.

Lactate shuttles between cells and inside cells as part of the normal metabolic process. But lactate is also involved in diseases that include inflammation, inadequate oxygen supply to cells, restricted blood supply to tissues, and neurological degradation, in addition to cancer. Standard methods to measure lactate are based on reactions among enzymes, which require a large number of cells in complex cell mixtures. This makes it difficult or even impossible to see how different types of cells act when cancerous. The new technique lets researchers measure the metabolism of individual cells, giving them a new window for understanding how different cancers operate. An important advantage of this technique is that it may be used in high-throughput format, which is required for drug development.

The research team used a bacterial transcription factor—a protein that binds to specific DNA sequences to control the flow of genetic information from DNA to mRNA—as a means to produce and insert the lactate sensor. They turned the sensor on in three cell types: normal brain cells, tumor brain cells, and human embryonic cells. The sensor was able to quantify very low concentrations of lactate, providing an unprecedented sensitivity and range of detection. The researchers found that the tumor cells produced lactate three to five times faster than the non-tumor cells. The open access journal *PLOS ONE* published this work in March. □

The Chilean government, through the National Commission for Scientific and Technological Research's (CONICYT) Basal Financing Program for Scientific and Technological Centers of Excellence, the Gobierno Regional de Los Ríos, and the National Fund for Scientific and Technological Development (Fondecyt); the National Institutes of Health; and the Carnegie Institution for Science supported this work.



Our galactic neighbor, the Large Magellanic Cloud, is about 200,000 light-years from Earth. Gas clouds collapse over time to form new stars producing celestial fireworks.

Image courtesy ESA/NASA/Hubble

Refining Hubble's Constant

An international team of astronomers including Carnegie's Ian Thompson has managed to improve the measurement of the distance to our nearest neighbor galaxy and, in the process, refine an astronomical calculation that helps measure the expansion of the universe.

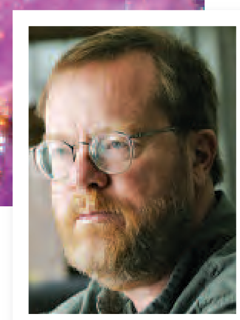
The Hubble constant is a fundamental quantity that measures the current rate at which our universe is expanding. Determining the Hubble constant is critical for gauging the age and size of our universe. One of the largest uncertainties plaguing past measurements has involved the distance to the Large Magellanic Cloud (LMC), our nearest neighboring galaxy.

The team refined the uncertainty in the distance to the LMC down to 2.2 percent. This new measurement can be used to decrease the uncertainty in calculations of the Hubble constant to 3 percent, with prospects of improving this to a 2 percent uncertainty in a few years.

Astronomers survey the scale of the universe by first measuring the distances to close-by objects and then using observations of these objects in more distant galaxies to pin down distances farther and farther out in the universe. But this chain is only as accurate as its weakest link. Up to now, finding a precise distance to the LMC has proved elusive. Because stars in this galaxy are used to fix the distance scale for more remote galaxies, an accurate distance to it is crucially important.

Because the LMC is close and contains a significant number of different stellar distance indicators, hundreds of distance measurements using it have been recorded over the years. Unfortunately nearly all the determinations have systemic errors, with each method carrying uncertainties.

The international collaboration worked out the distance to the LMC by observing rare close pairs of stars, known as eclipsing binaries. These pairs are gravitationally bound to each other, and once per orbit—as seen from Earth—the total brightness from the system drops as each component eclipses its companion. By tracking these changes very carefully, it is possible to work out how big the stars are, how massive they are, and other information about their orbits. When this is combined with careful measurements of their apparent brightness, remarkably accurate distances can be determined.



Ian Thompson

This method has been used before in taking measurements to the LMC, but with hot stars. As such, certain assumptions had to be made and the distances were not as accurate as desired. The team's new work used 16 years' worth of observations to identify a sample of intermediate mass binary stars with extremely long orbital periods, perfect for measuring precise and accurate distances.

The team observed eight of these binary systems over eight years. The LMC distance calculated using these eight binaries is purely empirical, without relying on modeling or theoretical predictions. The research was published in *Nature* in March. □

BASAL-Centro de Astrofisica y Tecnologias Afines (CATA), the Polish Ministry of Science, the Foundation for Polish Science (FOCUS, TEAM), the Polish National Science Centre, and the GEMINI-CONICYT fund supported this work. The European Research Council Advanced Grant program gave funding to the OGLE project.

Male Lions:
Not Slackers After All

Image courtesy Petr Kratochvil, publicdomainpictures.net

Male lions such as this one take down prey using ambush strategies, rather than the cooperative strategies favored by female lions.

It has long been believed that male lions are dependent on females when it comes to hunting. But new evidence suggests that male lions are, in fact, very successful hunters in their own right. A new report from a team including Carnegie's Scott Loarie and Greg Asner showed that male lions use dense savanna vegetation for ambush-style hunting in Africa.

Female lions have long been observed to rely on cooperative strategies to hunt their prey. While some studies demonstrated that male lions are as capable at hunting as females, the males are less likely to cooperate, so there were still questions as to how the males manage to hunt successfully. The possibility that male lions used vegetation for ambushing prey was considered, but it was difficult to study given the logistics and dangers of making observations of lions in densely vegetated portions of the African savanna. Loarie and Asner combined different types of technology to change the game. The team swept laser pulses across the African plains to create 3-D maps of the savanna vegetation. They did this using a Light Detection And Ranging (LiDAR) scanner mounted on the fixed-wing Carnegie Airborne Observatory (CAO) aircraft. They combined these 3-D habitat maps with GPS data on predator-prey interactions from a pride of seven lions in South Africa's Kruger National Park to quantify the lines of sight, or "viewsheds," where lions did their killing in comparison to where they rested.

The team found that a preference for shade caused both male and female lions to rest in areas with dense vegetation and similarly short viewsheds during the day; the real difference between males and females emerged at night. Female lions both rested and hunted under the cover of darkness in areas with large viewsheds. But male lions hunted at night in the dense vegetation—areas where prey is highly vulnerable, but which researchers rarely explore. The scientific results show that hunting success among male lions is linked to ambushing prey from behind vegetation, unlike the cooperative strategies employed by female lions in open grassy savannas. By strongly linking male lion-hunting behavior to dense vegetation, this study suggests that changes to vegetation structure—such as through fire management—could greatly alter the balance between predator and prey. With large mammals increasingly confined to protected areas, understanding how to maintain their habitat to best support their natural behavior is a critical conservation priority.

The authors emphasized that their findings should be confirmed in other studies throughout Africa's savannas. Nevertheless, these results could have major implications for park management, which is often heavily involved with manipulating vegetation. *Animal Behavior* published their work in March. □

Image below, courtesy Carnegie Airborne Observatory

Instrumentation is mounted on the fixed-wing Carnegie Airborne Observatory plane.

A grant from the Andrew W. Mellon Foundation funded this research. The Gordon and Betty Moore Foundation, the Grantham Foundation for the Protection of the Environment, Avatar Alliance Foundation, W. M. Keck Foundation, the Margaret A. Cargill Foundation, Mary Anne Nyburg Baker and G. Leonard Baker, Jr., and William R. Hearst III make the Carnegie Airborne Observatory possible.

Image courtesy NASA

This NASA Landsat 5 image shows the record-breaking algal bloom in Lake Erie in October 2011. The green scum is mostly *Microcystis*, a toxin to mammals.

algal Blooms Go Viral

A research team led by Carnegie's Anna Michalak determined that the 2011 record-breaking algal bloom in Lake Erie was triggered by long-term agricultural practices coupled with extreme precipitation, followed by weak lake circulation and warm temperatures. The team also predicted that, unless agricultural policies change, the lake will continue to experience extreme blooms. The research, published in the *Proceedings of the National Academy of Sciences* in April, was widely covered by the media.

Freshwater algal blooms can result when excessive amounts of phosphorus and nitrogen are added to the water, typically as runoff from agricultural fertilizer. These excess nutrients encourage unusual algae and aquatic plant growth. When the plants and algae die, the decomposers that feed on them use up oxygen, which can drop to levels too low for aquatic life to thrive. In the beginning, the Lake Erie algae were almost entirely *Microcystis*, an organism that produces a liver toxin and can cause skin irritation.

The scientists combined sampling and satellite-based observations of the lake with computer simulations. The algal bloom began in the western region of the lake in mid-July and covered an area of 230 square miles (600 km^2). At its peak in October, the bloom had expanded to over 1,930 square miles (5,000 km^2). Its peak intensity was over three times greater than any other algal bloom on record.

The researchers looked at numerous factors that could have contributed to the bloom, including land use, agricultural practices, runoff, wind, temperature, precipitation, and circulation. The use of three agricultural nutrient management practices in the area could lead to increased nutrient runoff: autumn fertilization, broadcast fertilization, and reduced tillage. These practices have increased in the region over the last decade.

Conditions in the fall of 2010 were ideal for harvesting and preparing the fields, including increasing fertilizer application for the following spring's planting. A series of strong storms in the spring of 2011 caused large amounts of phosphorus to run off into the lake. This onslaught resulted in among the largest observed spring phosphorus loads since 1975, when intensive monitoring began. Lake Erie was not unusually calm and warm before the bloom. But after the bloom began, warmer water and weaker currents encouraged a more productive bloom than in prior years. The longer period of weak circulation and warmer temperatures helped incubate the bloom and allowed the *Microcystis* to remain near the top of the water column, which had the added effect of preventing the nutrients from being flushed out of the system.

Anna Michalak

To determine the likelihood of future megablooms, the scientists analyzed climate simulations under both past and future climate conditions. They found that severe storms become more likely in the future; stronger storms, with greater than 1.2 inches (30 mm) of rain, could be twice as frequent. The authors also said that future calm conditions in between storms, with weak lake circulation after bloom onset is also likely to continue since current trends show decreasing wind speeds across the U.S. This would result in longer-lasting blooms and decreased mixing in the water column. □

This research is based upon work supported by the National Science Foundation (NSF) Water Sustainability and Climate program under grant no. 1039043, Extreme events impacts on water quality in the Great Lakes: Prediction and management of nutrient loading in a changing climate (see www.miseagrant.umich.edu/nsfclimate). Additional support for some of the co-authors was provided by NSF grant no. 0927643, the NOAA Center for Sponsored Coastal Ocean Research grant NA07OAR432000, and Lake Erie Protection Fund #SG 406-2011.

Sleuthing Early Tectonics

Researchers still have much to learn about the volcanism that shaped our planet's early history. New evidence from a team led by Carnegie's Frances Jenner demonstrates that some of the tectonic processes driving volcanic activity, such as those taking place today, were occurring as early as 3.8 billion years ago.

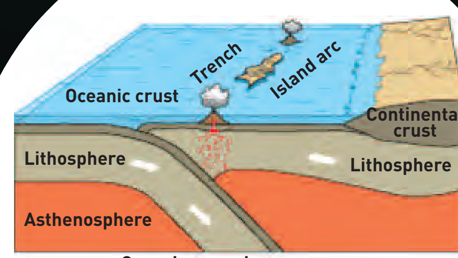
Upwelling and melting of the Earth's mantle at mid-ocean ridges, as well as the eruption of new magmas on the seafloor, drive the continual production of the oceanic crust. As the oceanic crust moves away from the mid-ocean ridges and cools, it becomes denser than the underlying mantle. Over time the majority of this oceanic crust sinks back into the mantle, which can trigger further volcanic eruptions. This process is known as subduction, and it takes place at plate boundaries.

Volcanic eruptions that are triggered by subduction of oceanic crust are chemically distinct from those erupting at mid-ocean ridges and oceanic island chains, such as Hawaii. The differences between the chemistry of magmas produced at each of these tectonic settings provide geochemical fingerprints that can be used to try to identify the types of tectonic activity taking place early in the Earth's history.

Previous geochemical studies have used similarities between modern subduction zone magmas and magmas that erupted about 3.8 billion years ago, during the Eoarchean era, to argue that subduction-style tectonic activity was taking place early in the Earth's history. But no one has been able to locate volcanic rock with compositions comparable to modern mid-ocean ridge or oceanic island magmas that were older than 3 billion years and were free from contamination by continental crust.

Because of this missing piece of the puzzle, it has been ambiguous whether the subduction-like compositions of volcanic rocks that erupted 3.8 billion years ago were really generated at subduction zones, or whether this magmatism should be attributed to other processes taking place early in the Earth's history. Consequently, evidence for subduction-related tectonics earlier than 3 billion years ago has been highly debated in the scientific literature.

Jenner and her team collected 3.8-billion-year-old volcanic rocks from Innersuartuut, an island in southwest Greenland, and found that the samples have compositions comparable to modern oceanic islands, such as Hawaii. The Innersuartuut samples may represent the world's oldest recognized collection of oceanic island basalts, free from contamination by continental crust. As such, this evidence strengthens previous arguments that subduction of oceanic crust into the mantle has been taking place since at least 3.8 billion years ago. *Geology* published their work in January. □



Oceanic-oceanic convergence

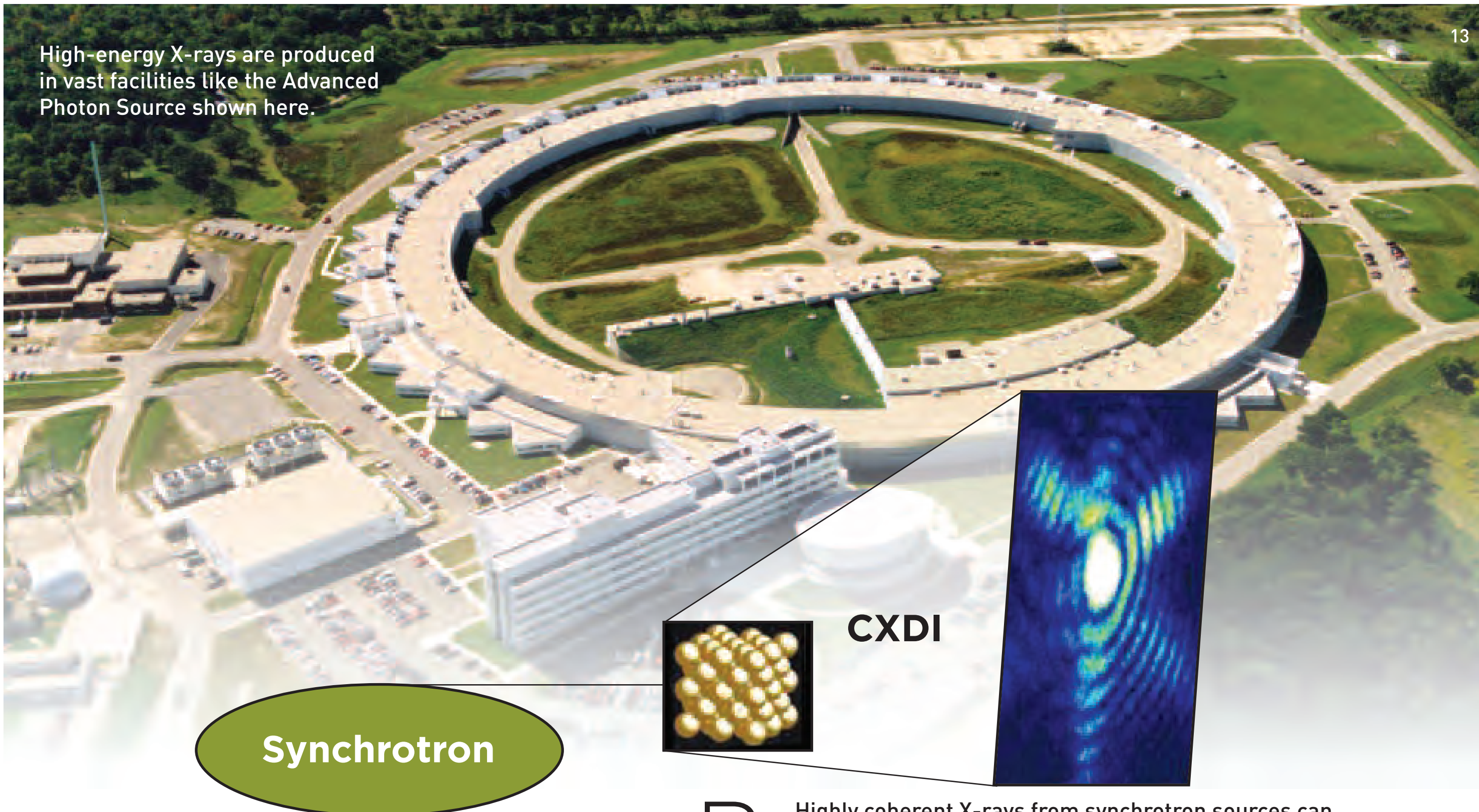
The Earth's plates move and can slide under each other in a process called subduction, which can cause volcanic eruptions.

Image courtesy USGS

Jenner and her team collected 3.8-billion-year-old volcanic rocks from Innersuartuut, an island in southwest Greenland. This NASA image shows the Greenland region.

Image courtesy NASA Goddard's Scientific Visualization Studio

An Australian International Postgraduate Research Scholarship, a Ringwood Scholarship, an ARC Discovery grant, and an NERC grant gave support to the authors of this study.



High-energy X-rays are produced in vast facilities like the Advanced Photon Source shown here.

Image courtesy Argonne National Laboratory

Highly coherent X-rays from synchrotron sources can be used for imaging nanomaterials in 3-D at tens of nanometers of spatial resolution. This image shows a monochromatic hard X-ray pattern from a single crystal gold particle, which produces a speckle-like fringe image.

Image courtesy Wenge Yang

NANOTECHNOLOGY BREAKTHROUGH

A team of researchers including Carnegie's Wenge Yang made a major breakthrough in measuring the structure of nanomaterials under extremely high pressures. The team developed a way to get around the severe distortions of high-energy X-ray beams that are used to image the structure of gold nanocrystals. This technique could lead not only to advancements of new nanomaterials created under high pressures, but also a greater understanding of what is happening in planetary interiors. *Nature Communications* published this work in April.

High pressures fundamentally change many properties of gold nanocrystals. The only way for researchers to see what happens to such samples when under pressure is to use high-energy X-rays produced by synchrotron sources. Synchrotrons can provide highly coherent X-rays for advanced 3-D imaging with resolution of tens of nanometers. This is different from the incoherent X-ray imaging with micron spatial resolution used for medical examinations.

The team found that by averaging the patterns of the bent waves—diffraction patterns—of the same crystal using different sample alignments of the instrumentation and by using a specially developed algorithm, they could compensate for the distortion and improve spatial resolution by two orders of magnitude. This is analogous to prescribing eyeglasses for the diamond anvil cell to correct the vision of the coherent X-ray imaging system.

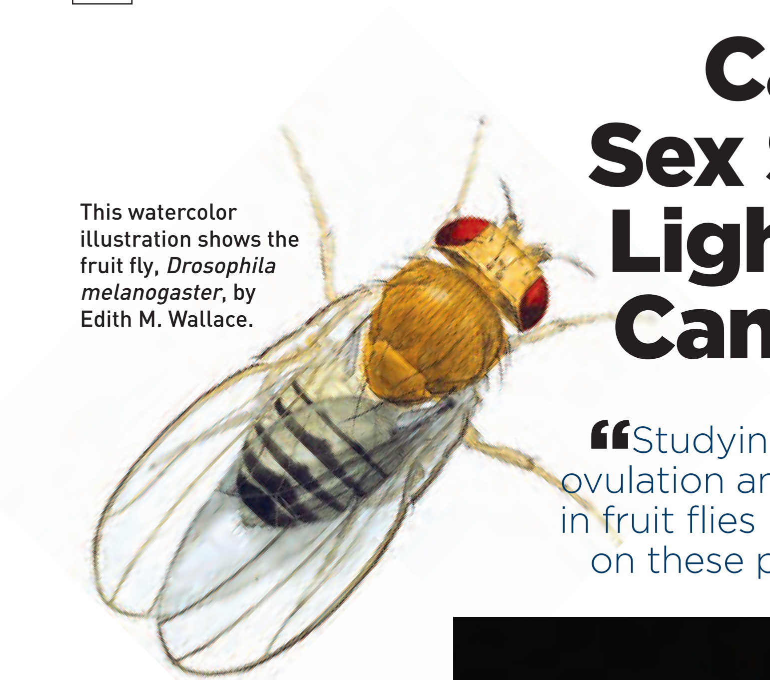
The researchers subjected a 400-nanometer (.000015 inch) single crystal of gold to pressures from about 8,000 times the pressure at sea level to 64,000 times that pressure. This latter is about the pressure in Earth's upper mantle, the layer between the outer core and the crust. They compressed the gold nanocrystal and found, as expected, that the edges of the crystal became sharp and strained. But to their complete surprise, the strains disappeared upon further compression. The crystal developed a more rounded shape at the highest pressure, implying an unusual plastic-like flow.

Gold nanocrystals are very useful materials. They are about 60% stiffer compared with other micron–sized particles, and they could prove pivotal for constructing improved molecular electrodes, nanoscale coatings, and other advanced engineering materials. This new structure measurement technique will be critical for advances in these areas.

Wenge Yang

Now that the distortion problem has been solved, the whole field of nanocrystal structures under pressure can be accessed. The scientific mystery of why nanocrystals under pressure are somehow stronger than bulk material may soon be unraveled. □

EFree, an Energy Frontier Research Center funded by DOE-BES, supported this work. DOE-BES supports the Advanced Photon Source.



This watercolor illustration shows the fruit fly, *Drosophila melanogaster*, by Edith M. Wallace.

Can Sex Shed Light on Cancer?

"Studying successful ovulation and fertilization in fruit flies has shed light on these processes."

Eggs take a long time to produce in the ovary. Researchers think that the body has mechanisms to help an ovary ensure that ovulated eggs enter the reproductive tract at a time that maximizes the chance of fertilization.

Studying successful ovulation and fertilization in fruit flies has shed light on these processes. Research from Carnegie's Allan Spradling and Jianjun Sun found that secretions from special glands within the fruit fly's reproductive tract contribute to both ovulation and sperm function and that the hormone receptor gene Hr39 controls this secretion. Their results also suggest that Lrh-1, a mammalian receptor gene closely related to Hr39, regulates ovulation by controlling reproductive tract secretions in mammals.

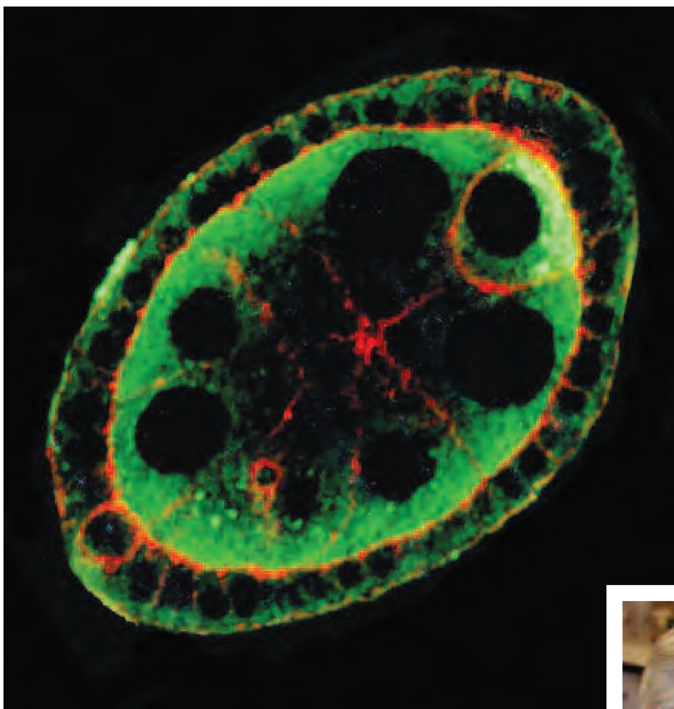
The biological processes underlying specific human tissues are often fundamentally similar to analogous tissues in seemingly very different species, even insects. These common processes are a consequence of the common evolutionary history of virtually all multicellular organisms. As a result of these similarities, researchers can genetically manipulate fruit flies to identify the genes and pathways controlling a biological process—in this case ovulation—and then use genome sequencing to identify the corresponding genes in other species, including humans.

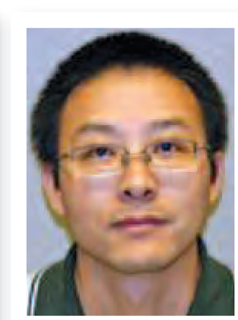
Spradling and Sun began such a strategy a few years ago by characterizing how the secretory glands within the ovary develop. Using advanced tools, they confirmed that one important role of reproductive tract secretions is to protect and store sperm; in humans, sperm is stored in the isthmus region of the fallopian tube. Sperm are thought to persist in the isthmus for only a few days, but they can last for a week or more in fruit flies. When reproductive tract secretion production is compromised, sperm have difficulty getting to the gland and those that can get there undergo abnormal changes.

The secretory "machinery" studied in these experiments may also allow the reproductive tract to signal the ovary when it is ready to receive an egg. Waiting for such a signal before releasing an egg could reduce the chance that an egg would fail to enter the reproductive tract or arrive before active sperm were available.

Spradling and Sun's work shows that different secretions are responsible for ovulation and for attracting and storing sperm. Identifying the specific secretory cell products (and the corresponding genes) required for successful ovulation is an important step in understanding the mechanisms of this still-mysterious process.

Their research also has a possible connection to one of the most common forms of ovarian cancer, one that derives from abnormalities in reproductive tract secretory cells. The genes and pathways that cells use in carrying out their normal functions are often the targets of the alterations that drive cancer cell growth. Spradling and Sun's work could stimulate an investigation of the role that genes such as Lrh1 play in this devastating disease. *eLife* published the findings in April. □





Above center: This microscopic image shows the formation of a fruit fly egg cell.
Above: Allan Spradling and Jianjun Sun

The Howard Hughes Medical Institute provided funding for this research.

InBrief

❶ Above right: Carnegie president Meserve was the keynote speaker at the Biennial General Meeting of the World Association of Nuclear Operators in Moscow in May.

❷ Trustee Michael Long, third from left, and Carnegie president Richard Meserve, fifth from left, were among the group of visitors to Carnegie's Las Campanas Observatory in Mar. Image courtesy Miguel Roth

Image courtesy Christine Pratt

❸ Participants gathered for a symposium in honor of Joe Gall's 85th birthday.

❹ Juliana Carten

❺ Shintaro Iwasaki

TRUSTEES AND ADMINISTRATION

❶❷ Carnegie president **Richard A. Meserve** testified before the House Committee on Energy and Commerce Subcommittee on Oversight and Investigations on Mar. 13 in Washington, DC, on an investigation on security at DOE weapon facilities he undertook at the request of the Department of Energy's (DOE's) then-Secretary Steven Chu. He chaired a meeting of the DOE's Nuclear Energy Advisory Committee on Mar. 14 and June 13 in Washington, DC. He chaired a meeting of the International Atomic Energy Agency's (IAEA's) international technical advisory group on Mar. 21-22 and June 10-11 and chaired the meeting of the IAEA's International Nuclear Safety Group on Apr. 23-24, all in Vienna, Austria. He visited the Las Campanas Observatory in Chile on Mar. 26-29 with a group of guests, including board member **Michael Long**. Meserve participated in a meeting of the Visiting Committee to the Harvard Kennedy School of Government on Mar. 3-5 and presided at meetings of the Harvard Board of Overseers on Mar. 6-7 and May 28-29, all in Cambridge, MA. He was a speaker on the lessons of the Fukushima accident at an event sponsored by the IAEA and the Canadian Nuclear Safety Commission on Mar. 9 in Ottawa, Canada. He attended meetings of the Council and Trust of the American Academy of Arts and Sciences in Cambridge, MA, on Apr. 18-19. He chaired a panel on advanced nuclear technologies at the National Academy of Sciences' annual meeting on Apr. 28 in Washington, DC. He introduced former Secretary of Energy Steven Chu at a stated meeting of the American Academy of Arts and Sciences on May 8 in Cambridge, MA. He attended meetings of the Council of the National Academy of Engineering on May 9-10 in Washington, DC. Meserve cochaired a meeting of the National Academies' Committee on Science, Technology, and Law on May 13-14, also in Washington, DC. He joined the celebration of the designation of the Department of Terrestrial Magnetism as an American Physical Society historical site, thanks to the work of Vera Rubin and Kent Ford confirming the existence of dark matter, on May 17. Meserve gave the keynote address at the World Association of Nuclear Operators Biennial General Meeting on May 20 in Moscow.

EMBRYOLOGY

Director **Allan Spradling** was an invited speaker at the Keystone Symposia "Stem Cell Regulation in Homeostasis and Disease." He also presented seminars at UCLA, The Johns Hopkins medical institutes, and BiogenIDEC. Spradling attended the Annual *Drosophila* Research Conference in Washington, DC. Also attending the conference and presenting posters were graduate student **Alexis Marianes** and postdocs **Steven DeLuca**, **Megha Ghildiyal**, **Ethan Greenblatt**, **Ming-Chia Lee**, **Robert Levis**, and **Vicki Losick**.

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❸ A two-day symposium in honor of Joe Gall's 85th birthday was held at the department Apr. 12-14. There were over 130 attendees including family, local and long-distance colleagues, current lab members, and Gall lab alumni from around the globe.

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Yixian Zheng presented a seminar in Shanghai and met with collaborators.

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Marnie Halpern presented her work at Georgetown U. and was the keynote speaker at the Regional Mid-Atlantic Society for Developmental Biology meeting at the College of William and Mary in Williamsburg, VA.

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Alex Bortvin was an invited speaker at the Keystone Symposia "RNA Silencing."

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Steve Farber presented his work and chaired a session in a workshop on using zebrafish in K-12 education at the Strategic Conference of Zebrafish Investigators in Asilomar, CA. He also attended the DEUEL Conference on Lipids in Napa Valley, CA. Postdoc **Jessica Otis** also attended the conference and presented a poster.

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Nick Ingolia was an invited speaker at Columbia U.

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Christoph Lepper was an invited speaker at U. Kentucky.

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Spradling postdoc **Ethan Greenblatt** received a three-year postdoctoral fellowship award from the Jane Coffin Childs Fund to support his project "Understanding Nuclear Aging in the *Drosophila* Follicle Stem Cell Lineage."

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Gall lab's postdoc **Jun-Wei Pek** received a three-year postdoctoral fellowship from the Life Sciences Research Foundation to support his project "Stable Intronic Sequences (sis) RNA: Novel Functions and Biogenesis Pathways."

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Halpern lab undergraduate researcher **Alice Hung** received a Johns Hopkins University (JHU) Provost's Undergraduate Research Award for her work in the Halpern lab. Alice presented a poster "Tissue Specific Activation of Estrogen Signaling in Development" at the award ceremony.

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❹ Farber lab's **Juliana Carten** successfully defended her Ph.D. thesis "Lipids and Microbes and Sugars, Oh My! Investigating Microbial and Dietary Influences on Fatty Acid Metabolism."

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The Fan lab's **Micah Webster** received a three-year postdoctoral fellowship award from the American Cancer Society to support his project "c-Met's Role in Satellite Cells During Muscle Regeneration."

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❺ **Arrivals: Steven DeLuca** joined the Spradling lab as a postdoc from UC-San Francisco. Student volunteer **Maddie Goodman** also joined the Spradling lab. **Shintaro Iwasaki** joined the Ingolia lab as a postdoc from U. Tokyo. Iwasaki is the recipient of both a Japan Society for the Promotion of Science award and a Human Frontier Science Program fellowship for his proposal on miRNA mediated translational activation by ribosome profiling. Lab technician **Stephanie Kuo** joined the Lepper lab**,** and animal technician **Andrew Rock** joined the fish facility.

Departures: Former graduate student **Katie McDole** left the Zheng lab to begin postdoctoral studies in Phillip Keller's lab at the Janelia Farm Research Campus. Postdoc **Helan Xiao** also left the lab after completing her postdoctoral project. **Julio Castañeda** is leaving the Bortvin lab for a postdoctoral position with Martin Matzuk at Baylor College of Medicine. Lab technician **Reid Woods** left the Lepper lab to pursue a medical degree. Business manager **David Lawrence** and animal technician **Brittany Hay** left the department.

GEOPHYSICAL LABORATORY

Robert Hazen delivered a Linus Pauling Memorial Lecture in Portland, OR; an "Evolution Matters" lecture at Harvard; and a Naff Lecture at U. Kentucky-Lexington. He was a keynote speaker at the Gordon Research Conference in Ventura, CA; at the Deep Carbon Science meeting in Washington, DC; at the EarthCube Stakeholders Workshop in Washington, DC; and at the Earth-Life Science Insti-

❻ A number of GL/CDAC affiliated staff attended the Mössbauer symposium, including Viktor Struzhkin, Jung-Fu Lin, Brent Fultz, and graduate students.

❼ Greg Asner (left) attended the St. James Palace meeting on tropical forest science in London May 8, where he met Prince Charles.
Image courtesy © Paul Burns

❽ Ken Caldeira

❾ Anna Michalak

❿ Yunatao Zhou

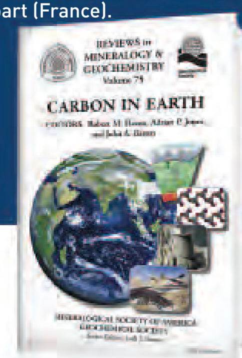
Deep Carbon Observatory

Carbon in Earth is the first major collective publication of the Deep Carbon Observatory (DCO). This special open-access volume provides an astonishing look at the new field of deep carbon science. The 700-page book contains 20 chapters by more than 50 researchers from nine countries, including **Robert Hazen**, **Russell Hemley**, **Craig Schiffries**, and **Anat Shahar** from the Geophysical Laboratory and **Conel Alexander** and **Steven Shirey** from DTM. *Carbon in Earth* was launched at the DCO International Science Meeting, which was held at the US National Academy of Sciences on Mar. 3-5. The meeting engaged more than 160 researchers from around the world, including many current and former Carnegie researchers. **Richard Meserve** provided opening remarks. **Russell Hemley** moderated a panel discussion with **Wendy Harrison** (NSF Earth Sciences Division Director; former Geophysical Lab predoctoral fellow), **P. Patrick Leahy** (AGI Executive Director), **Marcia McNutt** (USGS Director, 2009-2013), and **Frank Press** (National Academy of Sciences President, 1982-1993; Cecil and Ida Green Senior Fellow at Carnegie, 1993-1997). Perhaps nobody had a greater indirect impact than **Douglas Rumble**, who's had three former postdoctoral fellows—**Shuhei Ono**, **Craig Schiffries**, and **Edward Young**—on the plenary program. DCO held a Deep Energy Workshop in Manchester, England, Jan. 30-Feb. 1; an executive committee meeting in Washington, DC, on Mar. 5; and a workshop on abiotic hydrocarbons in Kazan, Russia, Apr. 13-17. □

Images courtesy Craig Schiffries

Top: The Deep Carbon Observatory executive committee met in the boardroom of the National Academy of Sciences on Mar. 5. Front row (from left): Jesse Ausubel (US), Isabelle Daniel (France), Adrian Jones (UK), John Baross (US). Middle row (from left): Sara Hickox (US), Craig Manning (US), Nickolay Sobolev (Russia), Russell Hemley (US), Barbara Sherwood Lollar (Canada), Eiji Ohtani (Japan), Taras Bryndzia. Back row (from left): Craig Schiffries (US), Kai-Uwe Hinrichs (Germany), David Cole (US), Robert Hazen (US), Erik Hauri (US), Claude Jaupart (France).

Members of the International Science Meeting of the DCO presented recent findings in Mar. From left to right: Frank Press, P. Patrick Leahy, Marcia McNutt, Wendy Harrison, Russell Hemley.



tute International Science Conference in Tokyo, Japan, to which he was also named to the advisory board. He also lectured on the coevolution of the geosphere and biosphere at Harvard U.; Arizona State U.; Rockefeller U.; the Cliff Salon, Scientists Cliffs, MD; and the Alfred P. Sloan Foundation in New York City.

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Director Emeritus **Wesley Huntress** retired from service after completing his second term on NASA's Advisory Council (NAC) and as chair of the NAC Science Committee in Apr.

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Ho-kwang (Dave) Mao presented the plenary speech "Breakthroughs in High Pressure Science and Technology" at the Study of Matter at Extreme Conditions (SMEC) 2013 cruise meeting on Mar. 23. He also delivered a plenary talk "Energy Frontier Research in Extreme Environments" at the GCOE-TANDEM International Symposium 2013 on Mar. 6 in Matsuyama, Japan.

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❻ Postdoctoral fellow **Caitlin Murphy** presented an invited talk at the 7th North American Mössbauer Symposium on Jan. 10-12 at U. Texas-Austin. It was organized by Geophysical Lab alum **Jung-Fu (Afu) Lin**. Caitlin also presented a geochemistry seminar at U. Maryland-College Park on Jan. 30.

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Microbeam specialist **Katherine Crispin** gave an invited talk "Diffusion in Oxides and Implications for Mantle Mineralogy" and a diffusion seminar at the Lamont-Doherty Observatory, Columbia U., on Apr. 17.

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HPSYNC/HPCAT

Yuming Xiao attended the 7th North American Mössbauer Symposium in Austin, TX, on Jan. 11-12 and gave an invited talk on nuclear resonant scattering under high pressure at HPCAT.

GLOBAL ECOLOGY

Director **Chris Field** was the keynote speaker at a convention of broadcast meteorologists at Lake Tahoe in Jan. He presented a keynote address at the European Climate Change Adaptation Conference in Hamburg, Germany, in Mar. and the "Earth Matters Distinguished Lecture" at the Stanford School of Earth Sciences that month.

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❼ **Greg Asner** and the CAO spectranomics team made a collecting trip to Panama's Barro Colorado Island in Jan. The team included **Robin Martin**, **Byron Tsang**, **Katie Kryston**, **Kelly McManus**, and three Peruvian climbers.

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❽ **Ken Caldeira**, **Jana Maclaren**, and **Lilian Calderia** spent five weeks in Feb./Mar. on One Tree Island on Australia's Great Barrier Reef. They were involved in field studies, testing the consequences of antacid in the ocean water for the growth of coral. NPR's Richard Harris joined the field expedition and featured it in two stories, one on *All Things Considered* and one on *Morning Edition*.

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❾ **Anna Michalak** was appointed editor of the journal *Water Resources Research*, a premier journal for hydrology and water resources published by the American Geophysical Union (AGU). She is the first woman editor of the journal in its 50-year history. Michalak was invited to become a member of the Science Advisory Board of the Climate Change Science Institute at Oak Ridge National Laboratory. She gave a keynote address at the North American Carbon Program All-Investigators Meeting in Albuquerque, NM, and was an invited panelist at the Society for Industrial and Applied Mathematics (SIAM) Conference on Computational Science and Engineering.

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❿ **Yuntao Zhou** defended her dissertation "Improved Estimates of the Spatial Distribution and Temporal Trends of Water Quality Parameters Using Geostatistical Data Fusion Methods" on Jan. 15th.

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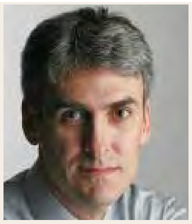
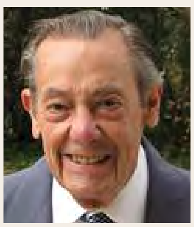


⓫ Andrew McWilliam

⓬ Plant Biology director Wolf Frommer



⓭ Winslow Briggs

⓮ Sue Rhee

⓯ Jóse Dinneny

⓰ Devaki Bhaya

Yoichi Shiga won an Outstanding Student Paper Award from the AGU for his presentation "Exploring the Ability of Inverse Methods to Isolate the Fossil Fuel Emission Signal from Atmospheric CO_2 Measurements" at the AGU fall meeting in San Francisco.

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Shouren Zhang, from the Chinese Institute of Botany in Beijing, is visiting the Berry Lab through the end of Aug. He has worked mostly on the ecophysiology of trees.

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Arrivals: Xuemei (Mei) Qiu joined the Michalak lab as a scientific programmer in Feb. **Jovan Tadic** became postdoctoral researcher in that lab in Mar. **Brando Paolo** began a postdoc position in the Asner lab, while **Byron Tsang** joined as a lab manager and **Katherine Kryston** as a lab technician, all in Jan. **Morvarid Tavassoli** began working as a lab technician for the Field Lab in Jan.

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Departures: Predoctorial visitor **Dario Caro**, in the Caldeira lab, returned to his home in Italy in Apr.

OBSERVATORIES

Director **Wendy Freedman** attended a Physics of the Universe Summit, in West Hollywood, CA, Jan. 11-13. On Jan. 23 she gave a colloquium on the cosmic distance scale at U. Chile. She and Las Campanas director **Miguel Roth** visited the Fundación Chile to introduce astronomy into the K-12 curriculum. She presented a talk on recent results on the Hubble constant at the Canadian Institute for Advanced Research Feb. 15-17. Apr. 1-5 she attended an international meeting in the Netherlands, discussing the implications of the Planck results for cosmology. On Apr. 22 Freedman gave a colloquium on recent measurements of the Hubble constant at U. Pennsylvania. She also gave the Elon Musk Public Lecture "A Journey of Discovery: Our Expanding Universe." During Mar. and Apr. she gave four talks to groups in the Los Angeles area on the Giant Magellan Telescope (GMT).

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⓫ Staff astronomer **Andrew McWilliam** gave an astronomy colloquium at Texas A&M U. titled "Chemical Evolution, Nucleosynthesis and the Chemical Composition of Stars in Dwarf Galaxies" on Apr. 1.

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Staff members **Luis Ho** and **Barry Madore** and Carnegie fellow **Guillermo Blanc** attended a meeting Mar. 24-29 in Lijiang, China, titled "Dissecting Galaxies with 2D Wide-Field Spectroscopy." Ho chaired the Scientific Organizing Committee for the international meeting and hosted a workshop on black holes at the Key Laboratory for Particle Astrophysics (CAS). Madore gave the first public talk on TYPHOON, a new application of the wide-field CCD on the Iréné du Pont 2.5-meter telescope at Las Campanas to produce data cubes for galaxies of extremely large angular size. Guillermo talked about VENGA, the instrument he used for his U. Texas thesis.

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Luis Ho also gave colloquia at the National Astronomical Observatories, Chinese Academy of Sciences (NAOC) and Hong Kong U.

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Staff astronomer **Josh Simon** gave the colloquium at UC-Santa Cruz on Jan. 30.

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On Mar. 12, staff associate **Andrew Benson** gave a talk "What Can Theoretical Models Predict for GMTIFS Observations?" at the GMT Integral-Field Spectrograph (GMTIFS) workshop held at the Observatories. He presented the opening talk "Galaxy Formation Models: Past, Present & Future" on Mar. 21 at the Stimulating Universes for Future Surveys meeting at the International Center for Radio Astronomy Research at U. Western Australia, Perth.

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In Jan. postdoctoral research associate **Nimish Hathi** attended the American Astronomical Society meeting in Long Beach, CA, and gave the talk "Investigating HST/WFC3 Selected Lyman Break Galaxies at z=1-3" in an HST UV special session. He was also a judge for the Chambliss Poster Award at this meeting.

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Postdoctoral research associate **Rik Williams** gave an invited talk at the Institute for the Physics and Mathematics of the Universe, Tokyo, Japan, titled "Galaxy Evolution in the Thermal Era" on Jan. 23.

PLANT BIOLOGY

⓬ On Feb. 1 director **Wolf Frommer** presented the Nathan Edward Tolbert Lectureship in Plant Biochemistry seminar at Michigan State U., East Lansing, titled "In vivo Biochemistry with the Help of Genetically Encoded Sensors." He gave a Pioneers in Genomics Lecture titled "A Multi-Pronged Approach to Plant Nutrition: Pico-Sensors for Transport Gene Discovery and Regulation" at U. Illinois-Urbana on Feb. 26, and he presented the same talk for the Distinguished Lectures in Life Science at Pennsylvania State U., University Park, on Feb. 27. On Mar. 13-15 he attended the Grand Challenges Explorations (GCE) Agriculture & Nutrition Awardee Convening in Seattle, WA, and presented a poster about securing the global food supply by crop immunization. On Mar. 24 he attended the International Workshop on Plant Membrane Biology held in Kurashiki, Japan, and gave a seminar on nutrient uptake and translocation.

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⓭ On Feb. 3 **Winslow Briggs** gave a seminar at Global Ecology on plant fire survival. On Apr. 13 Briggs gave a similar lecture and then led a four-hour field trip for the docents of the Stanford U. Jasper Ridge Biological Preserve on

Greg Asner Elected to the National Academy of Sciences (NAS)

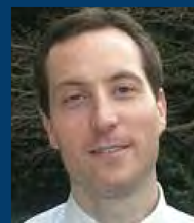
Greg Asner (right) is one of 84 new NAS members and 21 foreign associates from 14 countries elected this April "in recognition of their distinguished and continuing achievements in original research." The total number of active members now stands at 2,179.

Asner was hired in 2001 as the Department of Global Ecology's first staff scientist. Since coming to Carnegie, he has pioneered new methods for investigating tropical deforestation, degradation, ecosystem diversity, invasive species, carbon emissions, climate change, and much more using satellite and airborne instrumentation. His innovations measure the chemistry, structure, biomass, and biodiversity of the Earth in unprecedented detail over massive areas not thought possible before. He has developed new technologies for conservation assessments, including tropical forest carbon emissions and stocks, hydrologic function, and biodiversity. He leads the CLASLite forest change mapping project, spectranomics biodiversity project, and the one of a kind Carnegie Airborne Observatory (CAO). □

Carnegie Astronomy Lecture Speakers

The Carnegie Astronomy Lecture Series eleventh season was at the Pasadena Convention Center in Pasadena this year. Carnegie-Princeton/Hubble Fellow **Mansi Kasliwal** gave the first lecture, "Fireworks Lighting Our Universe," on Apr. 8. Other presenters were **Scott Sheppard**, staff scientist at Terrestrial Magnetism, postdoctoral associate **Jeff Rich**, and Carnegie fellow **Ian Roederer**.

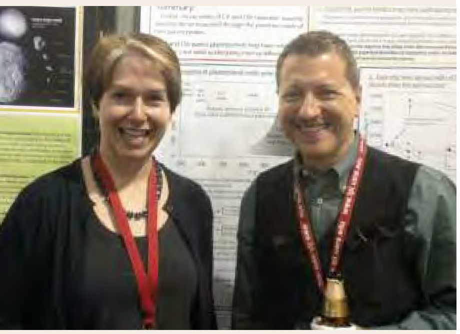
Mansi Kasliwal



Scott Sheppard

Jeff Rich

Ian Roederer



⓱ DTM director Lindy Elkins-Tanton with Brent Sherwood (JPL) attended the poster session during the 44th LPSC in Houston, TX.

⓲ Staff scientist Alycia Weinberger participated in commissioning the Magellan Adaptive Optics system at Las Campanas Observatory in Apr.

the recovery of vegetation in Henry W. Coe State Park, which he has been studying since a 2007 wildfire.

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Zhiyong Wang gave a seminar at U. Texas-Austin on Mar. 19 about hormonal and environmental signaling crosstalk in *Arabidopsis*. On Apr. 9 he gave a talk on plant signal integration in development at the Howard Hughes Medical Institute (HHMI) as a semifinalist of the HHMI Investigator Competition. He gave two talks on brassinosteroids signaling networks at the IV Brazilian Symposium on Plant Molecular Genetics in Bento Gonçalves, Brazil, on Apr. 11.

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⓮ On Mar. 4-6 **Sue Rhee** talked about genomic signatures of plant-specialized metabolism at the Evolution of Metabolic Diversity held at the Banbury Center, Cold Spring Harbor Labs, NY.

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⓯ **Jóse Dinneny** spoke about how local environmental cues control branching in roots at the American Society of Plant Biologists (ASPB) Western Section Meeting 2013, held in Davis, CA, on Apr. 12-13.

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⓰ On May 1 **Devaki Bhaya** presented an invited talk on the context and conflict in microbial communities at the Frontiers in Biology conference at Stanford U.

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Matt Evans and postdoctoral researchers **Antony Chettoor** and **Yongxian Lu** attended the 55th Annual Maize Genetics Conference Mar. 14-17 in St. Charles, IL. Lu presented posters at the Sustainable Plant Yield in a Changing Climate, ASPB meeting in Davis, CA, on Apr. 12-13.

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Eva Huala gave two talks, "*Arabidopsis* Phenotype Representation Using Ontologies" and "Application of Ontologies to Plant Gene Function and Phenotype Data," at the Plant and Animal Genome (PAG) XXI, International *Arabidopsis* Informatics Consortium Workshop held Jan. 12-16 in San Diego, CA. She presented a seminar at the Third Phenotype RCN Summit held Feb. 25-27 at the National Evolutionary Synthesis Center, Durham, NC.

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Donghui Li, a curator in the TAIR group, gave the talk "Gene Ontology Task at BioCreative IV" at the Sixth International Biocuration Conference Apr. 7-10 in Cambridge, UK.

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On Apr. 5-6 **Bob Muller**, lead curator in TAIR, talked about the PLAIN project at the GMOD/Biocuration 2013 meeting in Cambridge, UK.

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Bhaya Lab postdoctoral associate **Anchal Chandra** attended a workshop held Mar. 24-30 at the QB3 facility at Mission Bay Campus, UC-San Francisco. The workshop focused on intensive microscope-based instruction.

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Dinneny lab graduate students **Neil Robbins II**, **Yu Geng**, and **Rui Wu** and postdoctoral researchers **Lina Duan**, **Jóse Sebastian**, and **Ruben Rellan-Alvarez** attended the ASPB Western Section meeting on Apr. 12-13. Robbins and Dinneny also attended the Maize Genetics Conference, Mar. 14-17, in St. Charles, IL.

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Arrivals: Garret Huntress joined the Departments of Plant Biology and Global Ecology on Jan. 15 as the IT Manager. He was formerly at the Geophysical Laboratory. Visiting student **Alejandra Londono** from ICESI U. Colombia joined the Frommer lab on Feb. 12. Visiting graduate student **Lauro Bucker** joined the Wang lab on Feb.16 from Federal U. of Rio Grande do Sul, Brazil. **Samuel Hokin**, a senior computational scientist from U. Wisconsin, started work in the Barton lab on Jan. 15.

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Departures: Postdoctoral researcher **Guido Grossmann** left the Frommer lab on Dec. 31 to become a group leader at U. Heidelberg, Germany. Visiting researcher **Yang Bai** departed from the Wang lab on Jan. 18 to return to the Harbin Institute of Technology, China. On Feb. 8 **Shanker Singh**, a database administrator in the TAIR group, left for a position in industry. Lab technician **Erika Valle-Smith** left the Frommer lab on Mar. 28 for a biotech company.

TERRESTRIAL MAGNETISM

⓱ In Feb. director **Lindy Elkins-Tanton** presented a talk at the Institute for Advanced Study, Princeton. She also presented a talk at U. Colorado-Boulder. In Feb. she was appointed to the NASA Mars 2020 Rover Science Definition team. In Mar. Elkins-Tanton attended a "Committee on Astrobiology and Planetary Science (CAPS)" meeting at the NAS, an AGU Council Meeting, and the 44th Lunar and Planetary Science Conference (LPSC) in TX where she presented the plenary Masursky Lecture, cochaired the "Planetary Differentiation Across the Solar System" session, and presented a poster. She also gave an invited talk at the "Volcanism, Impacts and Mass Extinctions: Causes and Effects" conference at the Natural History Museum in London in Mar. In Apr. Elkins-Tanton led a mission-planning meeting at JPL in Pasadena, CA. On Apr. 15-16 she hosted a workshop on the Siberian flood basalts and the end-Permian extinction at DTM. On Apr. 23 she cohosted a joint Carnegie/NASA public lecture at Carnegie's main administrative office in Washington, DC. On Apr. 29 a camera crew from HHMI, NOVA/PBS, and Holt Productions came to interview her and visit the nanoSIMS lab where she, staff scientist **Erik Hauri**, and MIT researcher Ben Black isolated and measured melt inclusions as part of their Siberia research. In May Elkins-Tanton attended the Kongsberg seminar at the Center for Earth Evolution and Dynamics in Norway, where she delivered the keynote lecture "Magma Ocean and Planetary Evolution."

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In Mar. **Conel Alexander** presented at the 44th LPSC in Houston, TX.

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In Jan. **Alan Boss** chaired NASA's Carl Sagan Fellowship review in Long Beach, CA. In Mar. Boss spoke about isotopic homogeneity and heterogeneity in the solar nebula at the 44th LPSC in Houston, TX. In Apr. he gave a talk about the orbital evolution of dust grains during FU Orionis outbursts at the meeting on

"Transformational Science with ALMA: From Dust to Rocks to Planets" in Waikoloa, HI.

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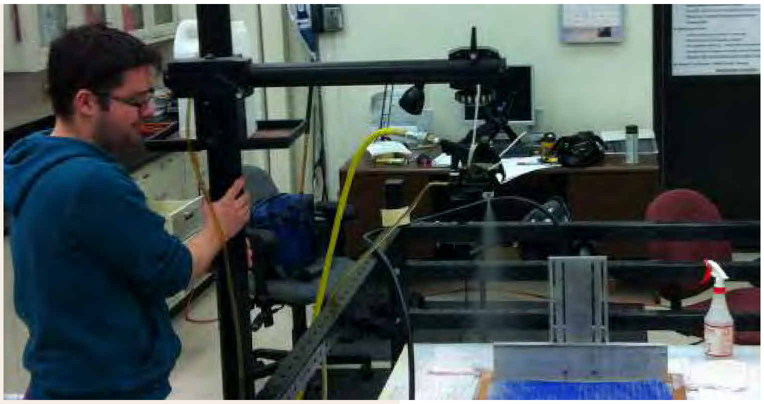
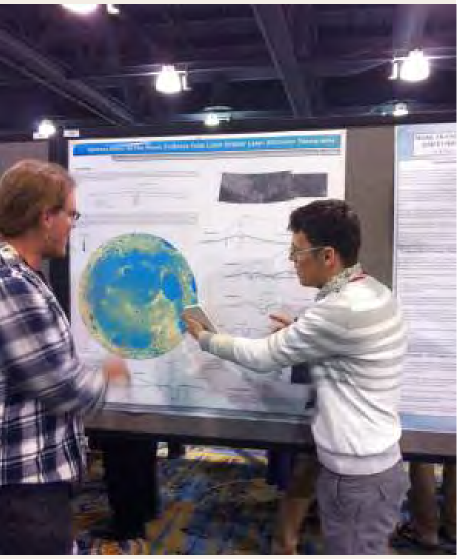
In Jan. **Rick Carlson** presented the "11th Annual Baldwin Frontiers in Geology Lecture" at Miami U., OH, on the "History of Earth Formation." Carlson also presented a seminar at U. Chicago in Feb. and a paper at the 44th LPSC in Houston in Mar.



⓳ MESSENGER postdoctoral associates Paul Byrne (pictured) and Christian Klimczak conducted analog experiments exploring the controls of the surface morphology of faulting in a contractional tectonic setting. They hope to relate the structures from their experiments to data from Mercury obtained by MESSENGER to learn more about the nature of the tectonics there. The innermost planet experienced significant contraction throughout its geologic history. Image courtesy Southwest Research Institute, San Antonio, TX.



⓴ MESSENGER postdoctoral associate Christian Klimczak discusses his poster at the 2013 LPSC Meeting in Houston, TX.

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Matt Fouch presented invited talks at U. Illinois-Chicago in Mar. and Princeton U. in Apr.

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Larry Nittler attended a MESSENGER Science Team Meeting in Columbia, MD, in Feb. and the 44th LPSC in Mar. He gave a seminar at U. Maryland in Apr. and attended a workshop on the composition and structure of Mercury's interior in Chicago. He also gave a talk in May on MESSENGER for the Royal Astronomy of Canada in Calgary and at a neighborhood lecture at Carnegie's Broad Branch Road campus.

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In Feb. **Diana Roman** gave an IRIS webinar called "The Secret Life of 'Quiescent' Volcanoes" and did fieldwork in Nicaragua in Mar. In early May she was a lecturer at the NSF 2013 Pan American Advanced Studies Institute (PASI) workshop on "Magma-Tectonic Interactions in the Americas" in León, Nicaragua.

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Scott Sheppard gave a public talk on Apr. 22 at the Pasadena Convention Center as part of the 11th season lecture series hosted by the Observatories. He also presented a more in-depth research talk there on Apr. 23. In late Apr. Scott presented at UCLA during their weekly lunch talk and also at the UCLA Institute for Planets and Exoplanets weekly seminar.

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Steve Shirey gave invited talks at Michigan State U., U. Rochester, U. Wyoming, Princeton U., and the Gemological Institute of America.

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⓲ In Feb. **Alycia Weinberger** participated in the AAS "Communicating with Congress" program and visited Congressional offices on Capitol Hill to advocate for science funding. In Mar. she gave an invited talk at the "Science with the Giant Magellan Telescope Integral-Field Spectrograph" meeting held at the Observatories. In Apr. she participated in commissioning the Magellan Adaptive Optics system at Las Campanas Observatory. In May Weinberger attended a panel review meeting for the US-Israel Binational Science Foundation in Jerusalem, Israel. In June she was an invited panelist at the IAU Symposium "Exploring the Formation and Evolution of Planetary Systems" in Victoria, Canada.

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Postdoctoral fellow **Hanika Rizo** won the second prize of "le Prix Jeune Chercheur," or Outstanding Young Scientist Award, by a panel in Clermont-Ferrand, France. Contestants were judged on both the content of their thesis and their ability to explain their research to a public audience.

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⓳ On Feb. 13 MESSENGER postdoctoral associate **Paul Byrne** gave an invited talk as part of the "Solar System Exploration Seminar" series at NASA Goddard Space Flight Center. On Feb. 18 he gave an invited talk at the Southwest Research Institute (SwRI). Between Feb. 18 and 22 he visited SwRI to conduct analog model laboratory experiments of crustal deformation on Mercury. On Feb. 27 he presented two talks at the 29th MESSENGER Science Team Meeting at the JHU Applied Physics Laboratory. On Mar. 20 Byrne gave a talk in the MESSENGER session at the 44th LPSC and then visited Virginia Tech to discuss mantle dynamics on Mercury. On Apr. 8 he gave two talks and chaired a session at the 2013 European Geosciences Union General Assembly, Vienna, Austria. On Apr. 22-24 he attended the 4th MESSENGER-BepiColombo Joint Science Meeting. Byrne also gave an invited talk at a volcanology workshop at NASA Goddard Space Flight Center on Apr. 30.

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Vera C. Rubin Fellow **Joleen Carlber** had an observing run at Las Campanas Observatory at the end of Jan. and at the end of Apr. Carlberg gave two seminar talks in Mar.—one at U. Delaware and the other at the Space Telescope Science Institute. She also virtually participated in the Stellar Stoichiometry Workshop in Apr.

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Postdoctoral fellow **Frances Jenner** presented a seminar at the Smithsonian Institution on Mar. 27 and another at the Lamont Doherty Earth Observatory on Apr. 3.

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⓴ MESSENGER postdoctoral associate **Christian Klimczak** accompanied **Paul Byrne** in Feb. to San Antonio, TX, for experiments in the state-of-the-art analog modeling laboratory at the SwRI. Also in Feb. Klimczak attended and presented a talk at the MESSENGER Science Team Meeting in Laurel, MD. In Mar. he attended the 44th LPSC where he made two presentations. On Mar. 28 he gave an invited talk about MESSENGER results at Virginia Tech. Klimczak also attended the 4th MESSENGER-BepiColombo Joint Science Meeting in Chicago.

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Deep Carbon Observatory (DCO) postdoctoral associate **Marion Le Voyer** visited the CRPG in Nancy, France, for one week in Oct. to work with DCO collaborators there. Utilizing their ion probe 1280-HR, the research goal was to test a new technique to analyze carbon isotopes in mid-oceanic ridge basalts—a challenge because these lavas have very low carbon contents. In Mar. Le Voyer and DCO postdoctoral associate **Jared Marske** presented posters at the DCO meeting at the NAS in Washington, DC.

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MESSENGER postdoctoral associate **Shoshana Weider** gave a talk at the MESSENGER session at the 44th LPSC in Mar., and she discussed MESSENGER, Mercury, and meteorites on NPR's Apr. 11 *All Things Considered.*

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Arrivals: Katherine Bermingham visited the geochemistry laboratory from U. Maryland to work with Rick Carlson measuring nucleosynthetic isotope anomalies in barium in primitive meteorites. In Feb. Merle A. Tuve Senior Fellow **David Bercovici** returned for a week for research with host Lindy Elkins-Tanton. Paul Butler and postdoctoral fellow Pamela Arriagada hosted the weeklong visit of UC-Santa Cruz Ph.D. student **Jennifer Burt**. Former DTM postdoc **Jonathan O'Neil**, now an assistant professor at U. Ottawa, visited to measure the hafnium isotope composition in zircons from the 3.8-billion-year-old granitoid rocks from the Nuvvuagittuq province in northern Quebec. In Jan. Judge **David Tatel** and his wife Edith presented the staff with a photograph of his father's telescope. Tatel's father is former DTM physicist Howard Tatel who, with Merle Tuve, built an explosion seismology program and was responsible for the first radio telescope**.** In Mar. Roman and Fouch hosted **Amanda Clarke** and **Alberto Behar**, professors from Arizona State U. Also in Mar. **Tomohiro Usui** (Tokyo Institute of Technology) visited to work on hydrogen isotopes in Martian meteorites with Conel Alexander and Jianhua Wang. A film crew from the Japanese NHK network accompanied Usui, for a documentary for the *Cosmic Front* series.

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Departures: Senior visiting investigator **Paul Rydelek** returned to Memphis, TN, following his three-month visit to work with Selwyn Sacks and Deborah Smith.☐

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CARNEGIE'S LYMAN THOMAS ALDRICH DIES

L. Thomas Aldrich

Lyman Thomas Aldrich, 95, a geophysicist and geochemist at the Department of Terrestrial Magnetism (DTM) for 34 years—including a term as DTM's acting director, died May 1.

Aldrich was part of a research team that pioneered the development of methods and instruments to determine the ages of rocks. The team used high-accuracy measurements of the isotope ratios of naturally occurring, long-lived radioactive decays—such as potassium decaying to argon, rubidium decaying to strontium, and uranium decaying to lead—to date a rock's constituent minerals. Aldrich's efforts were seminal to the group's work, which created many fundamental techniques used by geochemists around the world for the next 50 years or more. The accomplishments of this group and its postdoctoral fellows are legendary among geologists and geochemists.

Considering himself more a geophysicist than a geochemist, Aldrich became involved with seismic studies of the Earth's crust as a participant in the Carnegie expedition to study the crust of the central Andes in 1957.

Afterward, Aldrich took a more active role as a team leader for DTM's explosion-seismic experiments. He participated in several large-scale seismic experiments in the U.S. in the 1960s. He also served as the "shooter" for several international projects in the Andes in the early to mid-1970s, assembling and detonating charges of one to five tons in Andean lakes to generate seismic signals used to study crustal and upper mantle structure across the high Andes. In 1967 Aldrich joined in studies to determine electrical conductivity as a function of depth in the crust and upper mantle beneath the Altiplano of southern Peru, and he continued that research even into retirement.

Aldrich served as DTM's assistant director from 1965-1966, associate director from 1966-1974 (with Ellis Bolton as director), and acting director from September 1974-March 1975. He retired as a member of the scientific staff in 1984. □