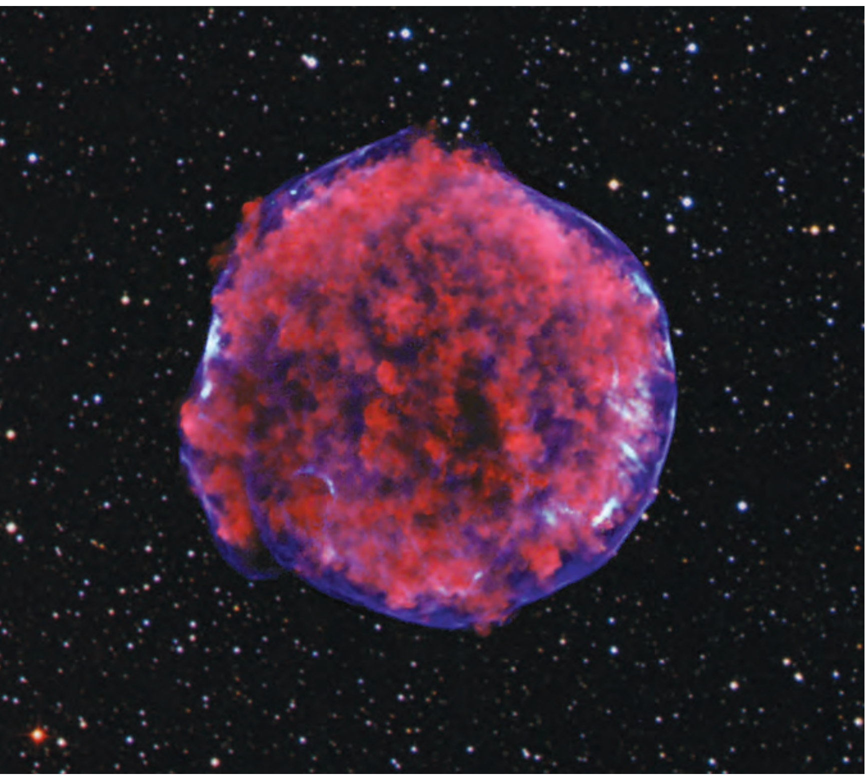
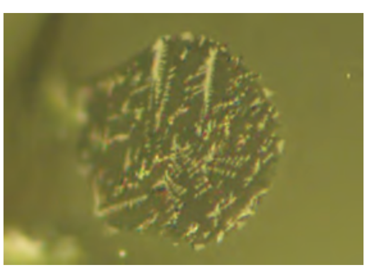
CarnegieScience

The Newsletter of the Carnegie Institution

FALL 2011

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

Why Join Carnegie?

Andrew Carnegie's purpose in establishing the institution was "to discover the exceptional man in every department of study . . . and enable him to make the work for which he seems specially designed his life work." This reflects Andrew Carnegie's awareness of the central importance of our researchers. With a remarkable crop of new recruits in every department, I know that we are succeeding in finding scientists of the caliber to which Carnegie aspired. But I decided to turn the issue around and to ask our new staff to explain why they had declined positions at other prestigious institutions and instead had decided to join us. The responses reflected several themes.

We always emphasize that we provide our scientists with an opportunity to pursue their own scientific paths to major discoveries. We are achieving our objective. One common theme from our new staff was that Carnegie researchers "have autonomy to a degree almost unmatched elsewhere in science." One said that the "intellectual freedom" offered by Carnegie "sets Carnegie apart from all other institutions." Another noted that "Carnegie is one of the very few places where I can focus on maintaining my own research program."

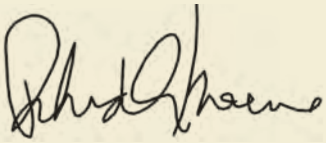
Another theme was the opportunity at Carnegie to work with exceptional colleagues and benefit from their "habit of collaboration." One noted that "combining autonomy with the caliber of scientists now at Carnegie opens possibilities for transformative rather than incremental science to an almost intoxicating degree." Another observed, "I wanted to be surrounded by the best people in [my] field, and the history that connects all of our research." Yet another said of his colleagues, "Not only are they outstanding scientists, they are also personable. The work environment is comfortable while it is stimulating." One said that "I could not imagine a more nurturing environment that would have helped our lab go further in the past one and a half years."

Carnegie strives to free its scientists to the extent possible from administrative or other responsibilities so that they can focus on cutting-edge science. One new scientist observed that "while I enjoyed teaching and mentoring students, my first love in science has been doing research. Carnegie is one of the very few places where I can focus on maintaining my own research program." Another observed that "Carnegie is one of the last places on Earth where a scientist can conduct work unfettered."

Our capacity to support our scientists from our endowment was also noted. One scientist observed that "an important aspect, which is sorely absent from most research institutes or university departments, is the core funding that is available. This resource enables high risk/high reward science to be performed . . . and to maintain a level of independence from the application-driven push in research funding today."

While we should never become complacent, the responses from the recent recruits suggest that we continue on the right track. We aspire to be unique and we are. Andrew would be proud.

Richard A. Meserve, *President*



NEW!

The president and the chairman of the board, Michael Gellert, will alternate roles in future issues in presenting an introductory letter.

A Carnegie Best

Frank A. Perret Volcanologist

BY SHAUN J. HARDY

An album of 50 hand-colored photographs documenting Japan's most powerful volcanic eruption of the 20th century was donated to the Geophysical Laboratory's archives by Susan W. Kieffer. The images depict Mount Sakurajima's 1914 activity and its aftermath and were compiled by Frank A. Perret (1867-1943), a volcanologist associated with Carnegie for much of his career. Perret's connection with the institution began around 1911 when the Geophysical Laboratory launched its own volcanology program.

Perret was assisted by honoraria at first, then later became a research associate—a position he held until his death. His masterful study, *The Vesuvius Eruption of 1906*, published by Carnegie in 1924, remains a model of careful observation, analysis, and photographic art. In January 1914, after a century of dormancy, Sakurajima ejected a towering ash column that blanketed the city of Kagoshima and nearby villages. Perret was 10,000 miles away in Naples, Italy, when news reached him, but he resolved to see it.

A successful American electrical engineer and inventor in the 1880s and '90s—he worked briefly in Thomas Edison's laboratory before launching his own company—Perret had turned to the study of volcanoes after reading accounts of Mount Pelée's catastrophic 1902 eruption. He lacked formal training in geology, but under the mentorship of the director of the Vesuvius Observatory he had proven himself an exceptional observer, expert photographer, and innovator of new instrumentation. His passion for volcanoes became engrossing. Author Tom Gidwitz wrote, "Perret never married, never engaged, and spent most of his adult years in near-solitary labor, communing with mountains, watching smoke and lava, listening to explosions."

Perret reached Sakurajima after the explosive phase, but he arrived in time to witness active lava flows and to collect samples. He photographed dramatic scenes, but not without peril. At one point a new vent suddenly blew out beneath an active lava stream he was studying. His companions had given him up for dead, but he escaped burned and battered.

Arthur L. Day, the first director (1906-1936) of the Geophysical Laboratory and a longtime supporter of Perret's work, considered Perret's color effects "beyond anything I have ever seen in a photograph. I am not sure that I could ever get used to the idea of rendering incandescent lava in brown and green." But to Susan Kieffer, the beauty of the photos is indisputable.

Kieffer, a professor of geology and physics at the University of Illinois at Urbana-Champaign, acquired the photo collection from a woman whose grandparents were friends of Perret's. She commented, "I thought it would be appropriate for Carnegie to have it because of Perret's career." □

1 Perret's hand-tinted photograph of the Sakurajima volcano in Japan, 1914

2 A scientist, believed to be Perret, collects samples of volcanic gases at Sakurajima, 1914.

3 Village houses are buried in ash from the Sakurajima volcano, 1914.

WHAT'S UP WITH THE MOON?

Carnegie researchers are finding out that what we thought we knew about the Moon probably isn't right.

IS IT YOUNGER?

Earth's Moon could be younger than previously thought, according to new research from a team that includes Terrestrial Magnetism's Richard Carlson and former Carnegie Fellow Maud Boyet. The study was published online in *Nature* on August 17.

The prevailing theory of our Moon's origin is that it was created by a giant impact between a large planetlike object and the proto-Earth. The energy of this impact was high enough that the Moon formed from melted material that was ejected into space. As the Moon cooled, this magma solidified into different mineral components.

Analysis of lunar rock samples thought to have been derived from the original magma has given scientists a new estimate of the Moon's age.

According to this theory for lunar formation, a rock type called ferroan anorthosite, or FAN, is the oldest of the Moon's crustal rocks, but scientists have had difficulty dating FAN samples. The research team, led by Lars E. Borg of the Lawrence Livermore National Laboratory, included Carlson, Boyet—now at Université Blaise Pascal—and James N. Connelly of the University of Copenhagen. They used newly refined techniques to determine the age of a FAN sample.

The team analyzed different versions—isotopes—of the elements lead and neodymium and dated the FAN sample's age at 4.36 billion years. This figure is 200 million years younger than earlier estimates of the Moon's age that range as old as 4.568 billion years. The new, younger age obtained for the oldest lunar crust is similar to ages obtained for the oldest terrestrial mineral—zircon from western Australia—suggesting that the oldest crusts on both Earth and Moon formed at approximately the same time, shortly after the giant impact.

This study is the first in which a single sample of FAN yielded consistent ages from multiple isotope dating techniques. This result strongly suggests that these ages pinpoint when the sample crystallized.

"The extraordinarily young age of this lunar sample either means that the Moon solidified significantly later than previous estimates, or that we need to change our entire understanding of the Moon's geochemical history," Carlson said. □

Funding for this work was provided by the U.S. Department of Energy. Portions of the work were supported by the NASA Cosmochemistry Program.

ORIGINS NOW QUESTIONABLE

The Moon has much more water than previously thought, a team of scientists led by Carnegie's Erik Hauri has discovered. Their research, published May 26 in *Science Express,* shows that magma trapped within crystals collected during the Apollo 17 mission contains 100 times more water than earlier measurements showed. These results could markedly change the giant impact theory about the Moon's origin.

The research team used a state-of-the-art NanoSIMS 50L ion microprobe to measure seven tiny samples of magma trapped within lunar crystals as so-called melt inclusions. These samples came from titanium-orange volcanic glass beads. The inclusion-bearing beads came from explosive volcanic eruptions, which brought them from depth eons ago. In contrast to most volcanic deposits, these melt inclusions are encased in crystals that prevent the escape of water and other volatiles during eruption.

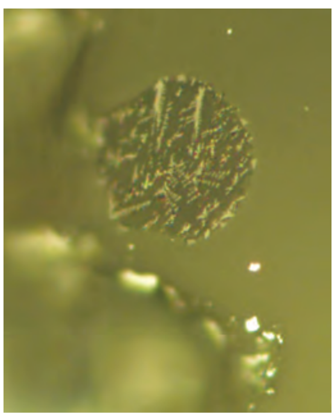
Compared with meteorites, Earth and the other inner planets contain relatively low amounts of water and volatile elements, which were not abundant in the inner Solar System during planet formation. The even lower quantities of these volatile elements found on the Moon has long been claimed as evidence that it must have formed following a high-temperature, catastrophic giant impact. But this new research shows that aspects of this theory must be reevaluated. The study also provides new momentum for studying similar samples returning from other planetary bodies.

"Water plays a critical role in determining the tectonic behavior of planetary surfaces, the melting point of planetary interiors, and the location and eruptive style of planetary volcanoes," said Hauri, a geochemist at the Department of Terrestrial Magnetism. "We can conceive of no sample type that would be more important to return to Earth than these volcanic glass samples ejected by explosive volcanism, which have been mapped not only on the Moon but throughout the inner Solar System."

Three years ago the same team, in a study led by Alberto Saal of Brown University, reported the first evidence for the presence of water in lunar volcanic glasses and applied magma degassing models to estimate how much water was originally in the magmas before eruption. Building on that study, Thomas Weinreich, a Brown University undergraduate, found the melt inclusions, allowing the team to measure the preeruption concentration of water in the magma and estimate the amount of water in the Moon's interior.

"The bottom line," said Saal, "is that in 2008, we said the primitive water content in the lunar magmas should be similar to the water content in lavas coming from the Earth's depleted upper mantle. Now, we have proven that is indeed the case."

The study also puts a new twist on the origin of water ice detected in craters at the lunar poles by several recent NASA missions. The ice has been attributed to comet and meteoroid impacts, but it is possible that some of this ice could have come from the water released by past eruptions of lunar magmas. □



(Top) Carnegie's Erik Hauri (left) sits with coauthor Alberto Saal in the lab.

Image courtesy Erik Hauri

(Bottom) This optical photograph shows an inclusion in the mineral olivine from an Apollo 17 sample.

Image used with permission from ©AAAS, *Science Express.*

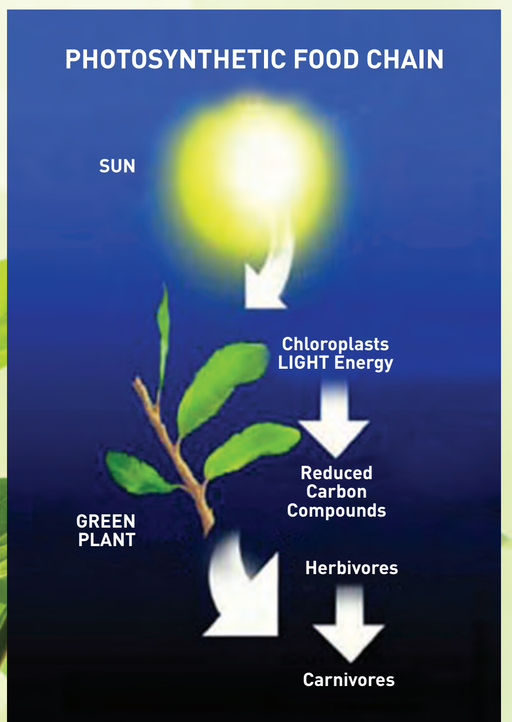
The paper's authors are Erik Hauri; Thomas Weinreich, Alberto Saal, and Malcolm Rutherford of Brown University; and James Van Orman of Case Western Reserve University. This research was supported by the Carnegie Institution for Science, NASA's LASER and Cosmochemistry programs, the NASA Lunar Science Institute, and the NASA Astrobiology Institute.

What Makes a Plant a Plant?

Arthur Grossman

PHOTOSYNTHESIS FEEDS us all. It is the process that plants and green algae use to make their food from the Sun's energy. That food becomes the basis of the food chain. Understanding what genes and proteins control the different aspects of photosynthesis is not simple. Scientists have been able to sequence the hereditary information or genomes of many organisms, but they still lack a context for associating the proteins encoded in genes with specific biological processes.

To better understand the genetics underlying plant physiology and ecology—especially photosynthesis—researchers including Carnegie's Arthur Grossman have identified a list of proteins in the genomes of plants and green algae, but not in the genomes of organisms that don't conduct photosynthesis. Their work, published June 17 in the *Journal of Biological Chemistry,* could help us to understand how photosynthetic cells might be tailored to survive changing environmental conditions.



In photosynthesis, plants convert energy from sunlight and carbon dioxide into organic compounds, particularly sugar—their own food.
Image courtesy NOAA

Using advanced computational tools, the scientists analyzed the genomes of 28 different plants and photosynthetic organisms. Grossman and his colleagues at the University of California in Los Angeles and the Joint Genome Institute of the U.S. Department of Energy were able to identify 597 proteins that are encoded on plant and green algal genomes but are not present in nonphotosynthetic organisms. They call this suite of proteins the GreenCut.

Interestingly, of the 597 GreenCut proteins, 286 have known functions, while the remaining 311 have not been associated with a specific biological process and are called "unknowns."

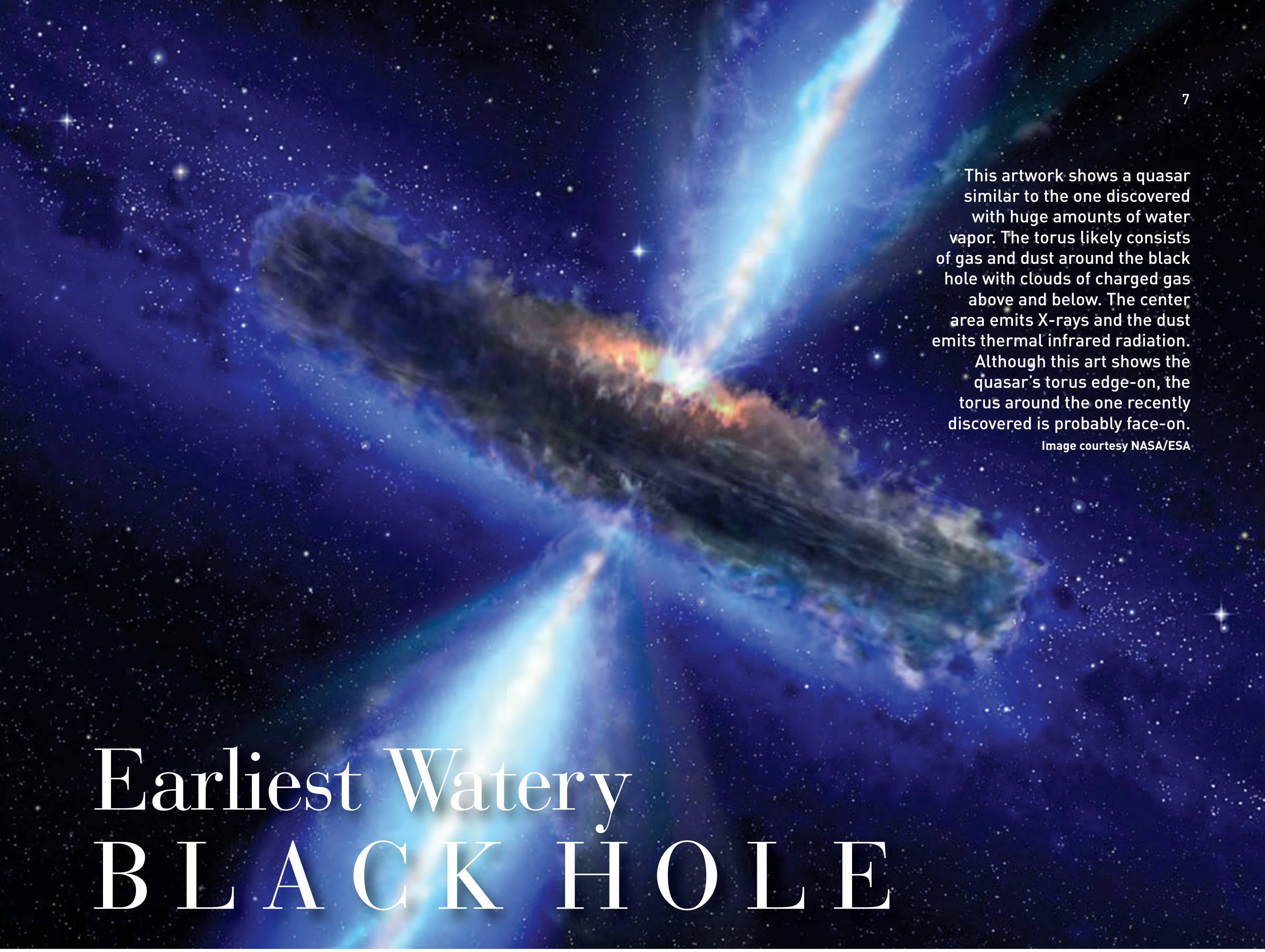
The majority of the GreenCut proteins, 52 percent, have been localized in a cellular organelle called the chloroplast—the compartment where photosynthesis takes place. It is widely accepted that chloroplasts originated from single-celled photosynthetic bacteria called cyanobacteria. They were engulfed by a more complex, nonphotosynthetic cell more than 1.5 billion years ago. While the relationship between the two organisms was originally symbiotic, over time the cyanobacterium transferred most of its genetic information to the nucleus of the host organism and lost its ability to live independently.

"This genetically reduced cyanobacterium, which is now termed a chloroplast, has maintained its ability to perform photosynthesis and certain other essential metabolic functions, such as the synthesis of amino acids and fat," Grossman explained. "The processes that take place in the chloroplast must also be tightly integrated with metabolic processes that occur in other parts of the the cell outside of the chloroplast."

While recent evidence suggests that many of the unknowns of the GreenCut are associated with photosynthetic function, not all GreenCut proteins are located in the chloroplast. But since they are unique to photosynthetic organisms and widespread throughout plants and other photosynthetic organisms, it is likely that they are critical for other plant-specific processes.

Expanding this work, Grossman and his colleagues found that many GreenCut proteins have been maintained in ancient cyanobacteria, red algae, and other single-celled algae called diatoms. Comparison of GreenCut proteins among various organisms is opening windows for discoveries about the roles that these proteins play in photosynthesis and the evolution of chloroplasts. As more is discovered, researchers hope to learn how photosynthetic cells could be designed for surviving different environmental conditions—a key to adapting to the changing climate. □

The work conducted by the U.S. Department of Energy Joint Genome Institute is supported by the Office of Science of the U.S. Department of Energy. Individual scientists were supported in part by a Ruth L. Kirschstein National Research Service Award from the NIH, a departmental Majeti-Alapati Fellowship, the National Science Foundation, and the U.S. Department of Energy.



This artwork shows a quasar similar to the one discovered with huge amounts of water vapor. The torus likely consists of gas and dust around the black hole with clouds of charged gas above and below. The center area emits X-rays and the dust emits thermal infrared radiation. Although this art shows the quasar's torus edge-on, the torus around the one recently discovered is probably face-on.
Image courtesy NASA/ESA

Earliest Watery BLACK HOLE

ASTRONOMERS HAVE FOUND the largest and farthest reservoir of water ever detected in the universe—in the central regions of a distant quasar. Quasars contain massive black holes that consume a surrounding disk of gas and dust; as it eats, the quasar spews out huge amounts of energy. The energy from this particular quasar was released some 12 billion years ago, only 1.6 billion years after the Big Bang. The research team includes Carnegie's Eric Murphy and the work is published in the journal *Astrophysical Journal Letters*.

The quasar's newly discovered mass of water exists in vapor form. The water is estimated to be at least 100,000 times the mass of the Sun and is equivalent to 34 billion times the mass of the Earth or 140 trillion times the mass of water in all of Earth's oceans put together.

The discovery of water is not in itself a surprise because astronomers expected water vapor to be present even in the early universe. There is water vapor in the Milky Way, but it is 4,000 times less massive than in the quasar. There is also frozen water in the Milky Way.

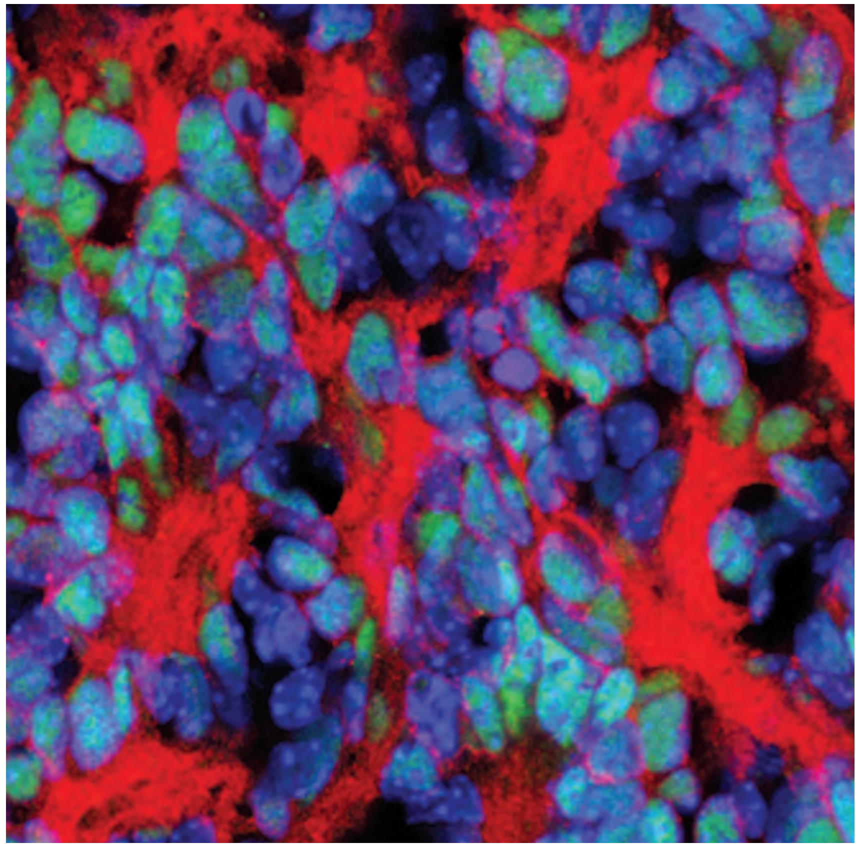
Water vapor reveals the nature of the quasar. In this case, the water vapor is distributed around the black hole in a gaseous region spanning hundreds of light-years (a light-year is about 6 trillion miles). The gas is unusually warm and dense by astronomical standards. It is five times hotter and 10 to 100 times denser than what is typical in galaxies like the Milky Way.

The large quantity of water vapor indicates that the quasar is bathing the gas in both X-rays and infrared radiation. The interaction between the radiation and the water vapor reveals how the gas is influenced by the quasar. Analyzing the water vapor also shows how the radiation heats the rest of the gas. Measurements suggest that there is enough gas for the black hole to grow to about six times its size. Whether or not this has happened is unclear, the astronomers say, since some of the gas could condense into stars or is being ejected from the quasar. □

Funding was provided by NSF, NASA, the Research Corporation, and the partner institutions. The Caltech Submillimeter Observatory is operated by the California Institute of Technology under a contract from NSF. CARMA was built and is operated by a consortium of universities—the California Institute of Technology, the University of California at Berkeley, the University of Maryland at College Park, the University of Illinois at Urbana-Champaign, and the University of Chicago—with funding from a combination of state and private sources as well as NSF and its University Radio Observatories Program.

Eye Tumors Meet MicroRNAs

New research from a team including several scientists from Embryology demonstrates that a specific small segment of RNA could play a key role in the growth of a type of malignant childhood eye tumor called retinoblastoma. The tumor is associated with mutations of a protein called Rb, or retinoblastoma protein. Dysfunctional Rb is also involved with other types of cancers, including lung, brain, breast, and bone. The work, featured on the cover of the August 15 issue of *Genes & Development,* could lay the groundwork for targeting a cure for this rare form of cancer and potentially other cancers.



This image is a close-up of retinoblastoma cells stained with two retinoblastoma markers.

Image courtesy David MacPherson

MicroRNAs are short, single strands of genetic material that bind to longer strands of messenger RNA—which is the courier that brings the genetic code from the DNA in the nucleus to the cell's ribosome, where it is translated into protein. This binding activity allows microRNAs to silence the expression of select genes in a targeted manner. Abnormal versions of microRNAs have been implicated in the growth of several types of cancer.

The paper from Carnegie's Karina Conkrite, Maggie Sundby, David MacPherson, and colleagues focuses on a cluster of microRNAs called miR-17~92. Recent research has shown that aberrant versions of this cluster are involved in preventing precancerous cells from dying and allowing them to proliferate into tumors. Previous work has shown that miR-17~92 can be involved in the survival of lymphoma and leukemia cells by reducing the levels of a tumor-suppressing protein called PTEN.

The team's new research shows that miR-17~92 can also be involved in retinoblastoma, although it does not act in the same way. Rather, miR-17~92 acts to help cells that lack the tumor-suppressing Rb protein to proliferate.

First the team demonstrated that miR-17~92 is expressed in higher-than-usual quantities in all human retinoblastomas examined and in some mouse retinoblastomas. The authors engineered mice to express high levels of miR-17~92 in their retinas. When coupled with inactivation of Rb family members, expression of miR-17~92 led to extremely rapid and aggressive retinoblastoma. Then they showed that this abundance of miR-17~92 acts to suppress an inhibitor of proliferation, called p21Cip1, which is understood to compensate for the loss of Rb.

"These findings— which show that miR-17~92 overcomes the cell's attempts to compensate for the loss of Rb—could be similar in other types of cancers," MacPherson said. "This microRNA cluster could represent a new therapeutic target for treating tumors caused by Rb deficiency." □

Portions of this work were funded by grants from the National Institutes of Health, the National Cancer Institute, the Knights Templar Eye Foundation, the Mukai Fund, and the Massachusetts Eye and Ear Infirmary.

Reforestation Chills Out

PLANTING ON PRODUCTIVE LAND with little snow enhances the potential for reforestation to counteract global warming, concludes new research from Global Ecology's Julia Pongratz and Ken Caldeira. Previous research suggested that regrowing forests on northern lands previously cleared to grow crops would not decrease global warming. But these studies did not consider the importance of the choices made by farmers.

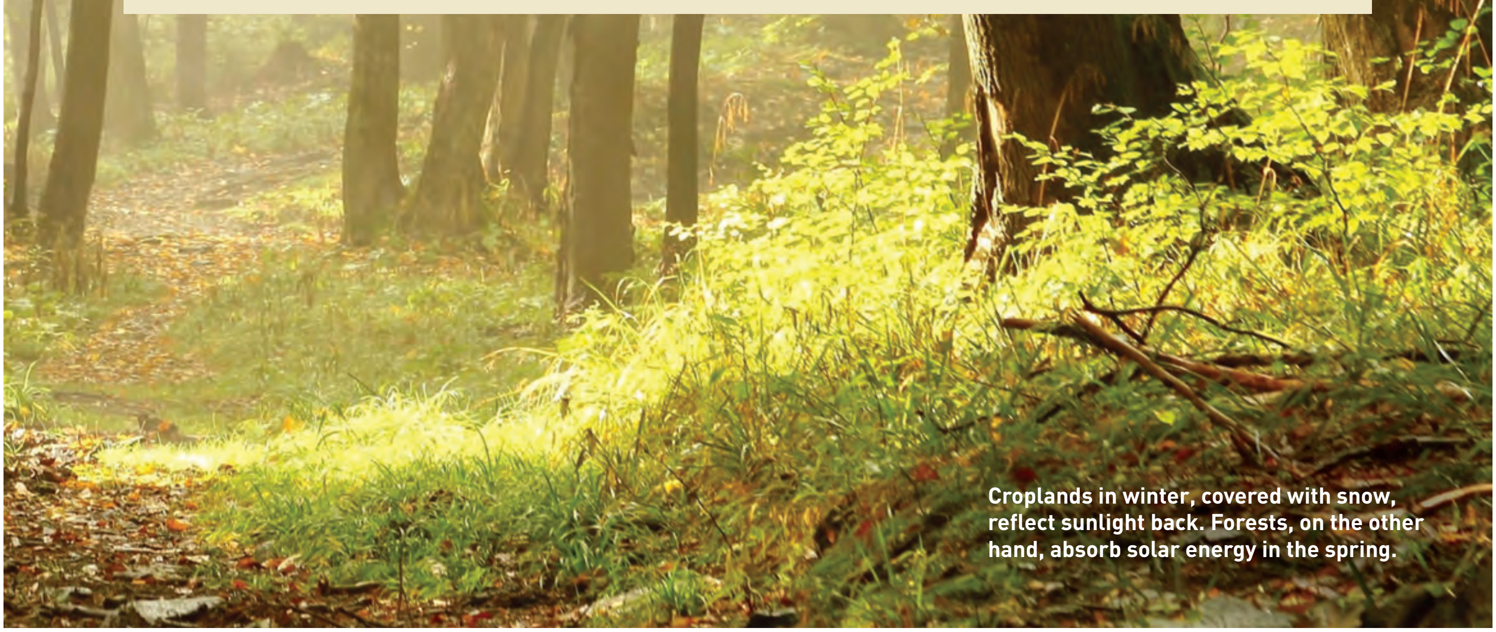
Carbon dioxide (CO_2) emissions from burning coal and oil and gas, as well as the clearing of forest, have been warming the Earth over the past several decades at least. One potential strategy for slowing or reversing this trend is to regrow forests on abandoned agricultural land that had previously been deforested. But the proposal has been difficult to evaluate because forests can either cool or warm the climate. The cooling effects come from CO_2 uptake. When forests grow, they absorb CO_2 from the atmosphere and store the carbon in plants and soil. Absorption of CO_2 has a cooling influence on our planet's temperature.

The warming effect comes from the absorption of solar radiation. Forests are often darker than agricultural lands and absorb more solar radiation. More important, forests in snowy areas in the spring often have snow-free and highly absorbing trees, when fields and pastures are still snow-covered and reflective. As a result, forests generally absorb more sunlight than fields or pasture, and this absorption has a warming effect.

The study by Pongratz and colleagues for the first time evaluated the climate cooling potential of reforestation taking historical patterns of land-use into consideration. They found that farmers generally chose to use land that was more productive than average, and therefore richer in carbon. They also chose to use land that was less snowy than average.

Researchers think that regrowing forests on these productive lands could take up a lot of the greenhouse gas carbon dioxide, and therefore have a strong cooling influence. Because these lands are not very snowy, regrowing forests would not absorb very much additional sunlight.

"Taking historical factors into account, we believe that we have shown that reforestation has more climate-cooling potential than previously recognized," Pongratz said. "We are still not yet at the point where we can say whether any particular proposed reforestation project would have an overall cooling or warming influence. Nevertheless, broad trends are becoming apparent. The cooling effect of reforestation is enhanced because farmers in the past chose to use productive lands that are largely snow free." The work, with colleagues from the Max Planck Institute for Meteorology and the University of Hamburg, was published August 2 by *Geophysical Research Letters.* □



Croplands in winter, covered with snow, reflect sunlight back. Forests, on the other hand, absorb solar energy in the spring.

Diamonds Pinpoint
Start of Colliding Continents

Diamond impurities are a bonanza for scientists. Safely encased in the super-hard diamond, impurities are unaltered ancient minerals that can tell the story of Earth's distant past. Researchers analyzed data from the literature of over 4,000 of these minerals and found that continents started the cycle of breaking apart, drifting, and colliding about 3 billion years ago. The research, published in the July 22 issue of *Science,* pinpoints when this so-called Wilson cycle began.

Lead author Steven Shirey at Terrestrial Magnetism explained, "The Wilson cycle is responsible for the growth of the Earth's continental crust, the opening and closing of ocean basins, mountain building, and the distribution of ores and other materials in the crust. But when it all began has remained elusive until now. We used the impurities, or inclusions, contained in diamonds, because they are perfect time capsules from great depth beneath the continents. They provide age and chemical information for a 3.5-billion-year span that includes the evolution of the atmosphere, the growth of the continental crust, and the beginning of plate tectonics."

Shirey conducted this research with coauthor and longtime colleague Stephen Richardson of the University of Cape Town.

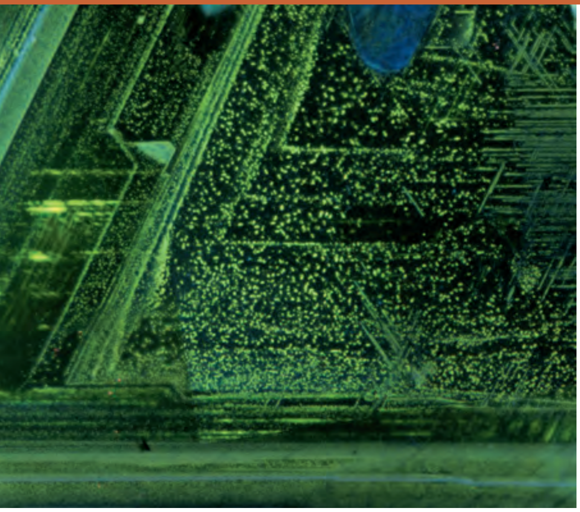
The largest diamonds come from cratons, deep mantle roots and the most ancient formations within continental interiors around which younger material aggregated. Cratons contain the oldest rocks on the planet. Their roots extend into the mantle more than 125 miles (200 km) where pressures are sufficiently high, but temperatures sufficiently low, for diamonds to form. The diamonds arrived at the surface during volcanic eruptions of deep magma that solidified into rocks called kimberlites. Diamond inclusions come in two major varieties: peridotitic and eclogitic. Peridotite is the most abundant rock type in the upper mantle, whereas eclogite is generally thought to be the remnant of oceanic crust recycled into the mantle by the sinking of tectonic plates, a process called subduction.

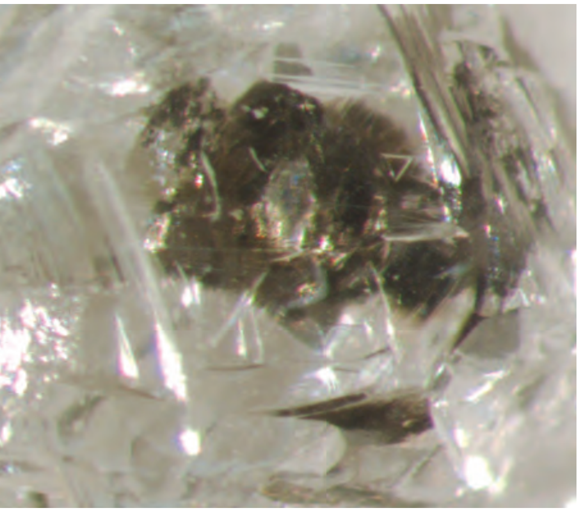
Shirey and Richardson used their own work with other coinvestigators that had been published in more than 20 papers over 25 years. They reviewed the data from more than 4,000 inclusions of silicate—the Earth's most abundant material—and more than 100 inclusions of sulfide from five ancient continents. They looked at when the inclusions were encapsulated and their associated compositions. Different compositions depend on the geochemical processing that the precursor materials underwent before they were encapsulated.

The scientists compared two systems used to date inclusions. Both rely on natural isotopes that decay at slow but predictable rates, making them excellent atomic clocks for determining ages. They found that before 3.2 billion years ago, only diamonds with peridotitic compositions formed. Subsequent to 3 billion years ago, however, eclogitic diamonds dominated. "The simplest explanation is that this change came from the initial subduction of one tectonic plate under the deep mantle keel of another as continents began to collide. The sequence of underthrusting and collision led to the capture of eclogite in the subcontinental mantle keel along with the fluids that are needed to make diamonds," said Shirey. "This transition marks the onset of the Wilson cycle of plate tectonics," concluded Richardson. □

This 2-millimeter octahedral diamond encases a peridotitic garnet. The garnet has significant aggregated nitrogen, which indicates it was stored over a billion-year timescale. It is from the Udachnaya kimberlite—a rock that formed from deep magma at the Siberian Craton.

Image courtesy Stephen H. Richardson, University of Cape Town





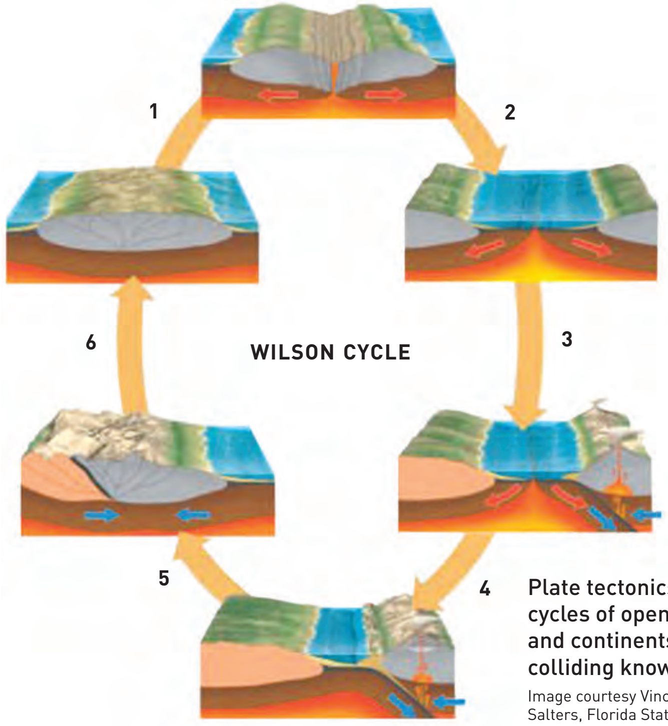


Plate tectonics is punctuated with cycles of opening and closing oceans, and continents breaking up and colliding known as the Wilson cycle.

Image courtesy Vincent J.M. Salters, Florida State University

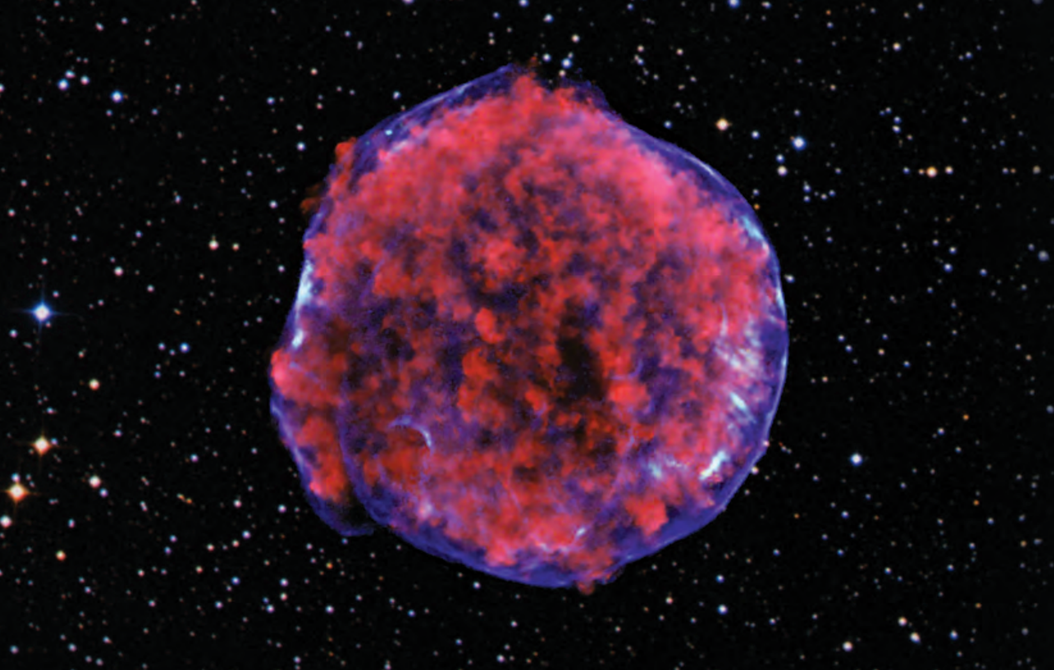
(Top) This illuminated eclogitic diamond from the Orapa kimberlite, Botswana, shows light green nitrogen-decorated platelets oriented along the crystallographic directions. The field of view is 1.5 millimeters. Platelets typically indicate an old age for a diamond.

(Bottom) This photomicrograph shows a rough diamond with a sulfide encased from the Orapa kimberlite in Botswana. Below the natural diamond growth surface, at center, are several hexagonal grains of iron sulfide surrounded by an irregular black rim. This rim is caused by internal fracture of the diamond on its 90-some-mile (150-kilometer) ascent to the Earth's surface via explosive volcanism of the magma. Sulfide grains like this reveal the age of the diamond and the composition of the sulfide. The diameter of sulfide grains is about 0.25 millimeters.

(Right) Steve Shirey works in the field.

Image courtesy Steven B. Shirey

SUPERNOVAE
Parents Found



The extraordinary example at left is a nearby Type Ia supernova remnant, called Tycho, recently observed by the X-ray telescope Chandra. Low-energy X-rays associated with the expanding material are shown in red; high-energy X-rays of the blast wave are shown in blue.

X-ray image courtesy NASA/CXC/Rutgers/K.Eriksen et al.; optical image courtesy DSS

TYPE IA SUPERNOVAE are violent explosions of stars. Their brightness is used to determine distances in the universe, which has led to the discovery that the universe is expanding at an accelerating rate, the foundation for the notion of dark energy. Although all Type Ia supernovae appear to be very similar, astronomers do not know for certain how the explosions take place and whether they all share the same origin, important information for determining the origin and consistency of their brightness.

Now a team of astronomers, including Carnegie Observatories researchers, has examined 41 of these objects and concluded that there are clear signatures of gas outflows from the supernova ancestors, which point to explosions of stars other than white dwarfs. The research is published in the August 12 issue of *Science*.

The prevailing theory is that Type Ia supernovae are thermonuclear explosions of a white dwarf star in a close system with another star. There are two competing scenarios for supernova ancestry. In one, the accompanying star in the system is a main-sequence star or evolved star. In the other, the companion is another white dwarf—a very dense star in its final evolutionary stage.

"Because we don't know what the things blowing up actually are, we don't quite understand why they should all be so similar," explained coauthor Josh Simon at Carnegie. "That raises the possibility that Type Ia supernovae that occurred 7 billion years ago—the ones that allow us to measure the repulsive force we call dark energy—might be different in some subtle way from the ones occurring now. Maybe they are a little bit brighter than the ancient ones, for example."

Carnegie's Mark Phillips added, "We wanted to get a better understanding of what the stars look like before the explosion to help determine the origin of their brightness. That information will allow us to be sure that there are no errors of this type distorting the dark energy measurements."

Sodium is a telltale sign of cool, neutral gas in the vicinity of the explosion. By measuring the speed of the sodium clouds in each of the supernovae, the team determined that most show sodium gas moving away from the explosion, toward the Earth.

"If the star system originally contained two white dwarfs before the supernova, then there shouldn't be any sodium," remarked Carnegie's Nidia Morrell. "The fact that we detected the sodium shows that one of the stars must not have been a white dwarf." The astronomers ruled out other possible sources of the sodium features.

"The low velocities and narrowness of the features suggest that the absorption is from material very close to the supernova that was ejected by the parent system before the explosion. Typically, gas with these characteristics is attributed to the stellar wind blown by red giant companion stars, not white dwarfs," remarked Simon.

The finding is an important first step toward understanding the details of how Type Ia supernovae explode and the origin of their immense luminosity. □

Josh Simon, Mark Phillips, Nidia Morrell, and Ian Thompson of the Observatories were part of the team investigating Type Ia supernova explosions.

Images courtesy the Observatories and Nidia Morrell

METAL GLASS?

GLASSES DIFFER FROM CRYSTALS. Crystals are organized in repeating patterns that extend in every direction. Glasses lack this strict organization, but do sometimes demonstrate order among neighboring atoms. New research from Carnegie's Geophysical Laboratory reveals the possibility of creating a metallic glass that is organized on a larger scale. The results were published June 17 in *Science* and could be used in a wide range of applications from better golf clubs to armor-piercing projectiles.

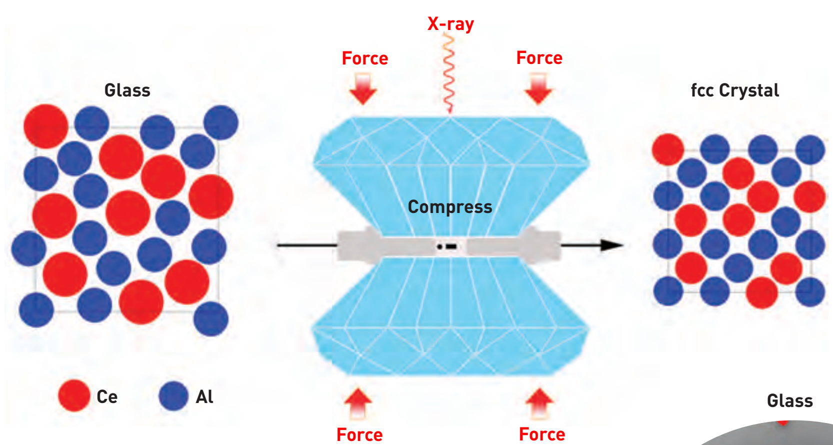
Scientists have discovered glasses that demonstrate order among the nearest neighboring atoms, called short-range order, and among a slightly wider range of atoms, called medium-range order. Most research about finding or creating a glass with a long-range, nearly crystalline, level of order—referred to as the perfect glass state—has been conducted on ice and the minerals silica and zeolite. But no effort to create long-range-order glass has been successful until now.

The research team, including Carnegie's Ho-Kwang (Dave) Mao, focused on metallic glass made from the elements cerium and aluminum. Metallic glasses are a hot research topic, because they are less brittle than ordinary glasses and more resilient than conventional metals. They combine the advantages and avoid many of the problems of normal metals and glasses, two classes of materials with a very wide range of potential applications.

Using X-ray techniques to study cerium-aluminum glass, the team determined that the atomic structures of cerium and aluminum prevent the glass from assuming a highly ordered state at normal pressures. By placing the cerium-aluminum glass under 25 gigapascals of pressure—about 250,000 times normal atmospheric pressure—the team was able to create a single crystal.

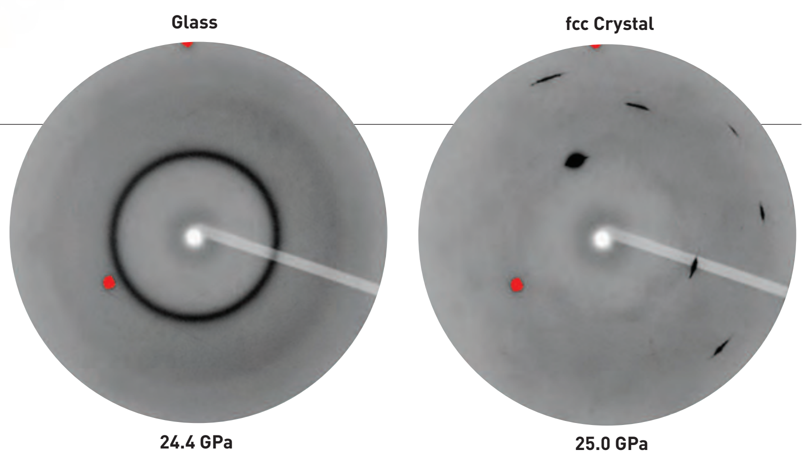
Under the intense pressure, an electron in cerium shifts, allowing the new crystalline structure to be created. When the glass was brought back to ambient pressure, the new structural order was preserved.

"These exciting results demonstrate that pressurized cerium-aluminum glass could be a favorable system for discovering the long-sought-after perfect glass," Mao said. "This situation could also exist in other metallic glasses." □



The schematic shows what happens when scientists subject the cerium-aluminum glass to pressures about 250,000 times normal atmospheric pressure. They created a single crystal. When the glass was brought back to ambient pressure, the new structural order was preserved.

Image courtesy Qiaoshi Zeng



The left image shows typical single-crystal glass structure under about 240,000 times atmospheric pressure (24.4 gigapascals). The image on the right shows that at 250,000 times atmospheric pressure (25 gigapascals), the glass has a crystal structure. (Red dots are masks.)

Image courtesy *Science Magazine*/ ©AAAS reprinted with permission

Funding for this research was provided by the U.S. Department of Energy Energy Frontier Research Center. The use of HPCAT, APS is supported by the Carnegie Institution for Science, Carnegie DOE Alliance Center, University of Nevada at Las Vegas, and Lawrence Livermore National Laboratory through funding from DOE-National Nuclear Security Administration, DOE-Basic Energy Sciences, and NSF. The TEM measurements were conducted at the Electron Microscopy Center at ANL. Computational work was supported by NSF and conducted on the supercomputing system supported by the Center for Computational Materials Science, Tohoku University. The SLAC effort is supported by DOE. Researchers from Zhejiang University were supported by the National Science Foundation of China, the China Postdoctoral Science Foundation, the Zhejiang University-Helmholtz Cooperation Fund, the Ministry of Education of China, and the Zhejiang Provincial Department of Science and Technology.

Meteorites
Ferry Life Tools to Earth

Meteorites hold a record of the chemicals that existed in the early Solar System and may have been a crucial source of the organic compounds that gave rise to life on Earth. Since the 1960s, scientists have been trying to find proof that nucleobases, the building blocks of our genetic material, came to Earth on meteorites. New research, published in an early online edition of the *Proceedings of the National Academy of Sciences,* indicates that certain nucleobases do reach the Earth from extraterrestrial sources by way of certain meteorites, and in greater diversity and quantity than previously thought.

Extensive research has shown that amino acids, which string together to form proteins, exist in space and have arrived on our planet piggybacked on a type of organic-rich meteorite called carbonaceous chondrites. But it has been difficult to similarly prove that the nucleobases found on meteorite samples are not due to contamination from sources on Earth.

The research team was led by Michael Callahan at the NASA Goddard Space Flight Center and included Jim Cleaves of Carnegie's Geophysical Laboratory. They used advanced spectroscopy techniques to purify and analyze samples from 11 different carbonaceous chondrites and one ureilite, a very rare type of meteorite with a different type of chemical composition. This was the first time all but two of these meteorites had been examined for nucleobases.

Two of the carbonaceous chondrites contained a diverse array of nucleobases and compounds that are structurally similar, so-called nucleobase analogs. Especially telling was the fact that three of these nucleobase analogs are very rare in terrestrial biology. What's more, significant concentrations of these nucleobases were not found in soil and ice samples from the areas near where the meteorites were collected.

"Finding nucleobase compounds not typically found in Earth's biochemistry strongly supports an extraterrestrial origin," Cleaves said.

The team tested their conclusion with experiments to reproduce nucleobases and analogs using chemical reactions of ammonia and cyanide, which are common in space. Their lab-synthesized nucleobases were very similar to those found in the carbonaceous chondrites, although the relative abundances were different. This could be due to chemical and thermal processing that the meteorite-origin nucleobases underwent while traveling through space.

These results have far-reaching implications. The earliest forms of life on Earth may have been assembled from materials delivered to Earth by meteorites.

"This shows us that meteorites may have been molecular tool kits, which provided the essential building blocks for life on Earth," Cleaves said. □

These images show two of the meteorites the team studied, Allan Hills (top) and Murchison.

Images courtesy NASA

Funding for various portions of this work was provided by the NASA Postdoctoral Program administered through Oak Ridge Associated Universities, the Goddard Center for Astrobiology, the NASA Astrobiology Institute, and NASA Astrobiology: Exobiology and Evolutionary Program. Meteorites were provided by the NASA Johnson Space Center, the Smithsonian Museum of Natural History, P. Ehrenfreund, P. Jenniskens, and M. Shaddad, the University of Melbourne, Australia, and the 2006 ANSMET team.

InBrief


❶ David MacPherson


❷ Christoph Lepper


❸ Megha Ghildiyal


❹ Tagide deCarvalho


❺ Carnegie business managers convened at Embryology in May.

Image courtesy Christine Pratt


❻ Geophysical Laboratory director Rus Hemley (left) talks with DOE Secretary Steven Chu (right) at the Argonne National Laboratory.

TRUSTEES AND ADMINISTRATION

Carnegie president **Richard A. Meserve** participated in meetings of the Blue Ribbon Commission on America's Nuclear Future on June 29 and July 18. He chaired a session on nuclear power after Fukushima at an Aspen Energy Institute Forum in Aspen, CO on July 6. He participated in an energy roundtable hosted by the Center for Strategic and International Studies in Washington, D.C., on July 13 and spoke to the Bohemian Club in Summer Grove, CA on July 16. On Sept. 1, he spoke at the Nuclear Regulatory Commission's event in commemoration of the 10th anniversary of the September 11 attacks. He cochaired a meeting of the National Academies' Committee on Conversion of Research Reactors on Sept. 1 and 2. He chaired a forum of the IAEA's General Conference on Sept. 19 in Vienna, Austria. He also cochaired a meeting of the National Academies' Committee on Science, Technology and Law on Sept. 26-27 in Washington, D.C.

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Brian Loretz joined the advancement team as senior manager of prospect research.

EMBRYOLOGY

Joe Gall presented a lecture at Baylor Coll. of Medicine and a paper at the Cold Spring Harbor Laboratory meeting on Eukaryotic mRNA Processing Aug. 23-27.

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Marnie Halpern spoke at the 7th European Zebrafish Meeting in July in Edinburgh. She was interviewed about her work on brain asymmetry for a news program for Russian television for International Left-Handers' Day on Aug. 13. She also presented a seminar at the Children's Hospital of Pennsylvania.

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Yixan Zheng presented a seminar at U. Texas Southwest Medical Center, spoke at the German Society for Cell Biology FEBS meeting, and presented her work at three conferences in China.

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Chen-ming Fan presented a seminar at U. Texas Southwest Medical Center and was an invited speaker in May at the European Molecular Biology Organization conference in Germany, "The Molecular and Cellular Mechanisms Regulating Skeletal Muscle, Development, and Regeneration."

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Alex Bortvin presented a talk at the Dept. of Terrestrial Magnetism on "The Taming of the Dark Matter of the Genome." In Aug. he also presented talks at the Gordon Research Conference Mammalian Gametogenesis & Embryogenesis, the FASEB meeting on Mammalian Mobile Elements, and the annual meeting of the Society for the Study of Reproduction.

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In July **Steve Farber** spoke at the Gordon Research Conference on Molecular & Cellular Biology of Lipids and at the Zebrafish Gastrointestinal Interest Group Workshop at the Mayo Clinic.

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In Aug. **Jeff Han** presented a talk at the FASEB meeting, "Mobile DNA in Mammalian Genomes."

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Nick Ingolia received a Searle Scholar Program Award for his proposal "Regulated Changes in Translation Initiation: Causes and Genome-wide Consequences." He will receive $300,000 over three years in support of his project.

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❶ **David MacPherson** received an American Cancer Society Research Scholar Award for his proposal "Collaboration between the RB Pathway and Oncogenic microRNAs in Cancer."

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❷ On July 1 **Christoph Lepper** was appointed a staff associate—a five-year independent junior faculty position. He will focus on the developmental growth and regeneration of skeletal muscle which relies on satellite stem cells, the tissue's stem cells. He received his Ph.D. from the Johns Hopkins U. Lepper was also awarded a 5-year, $1.25 million grant from a new program at NIH called the NIH Director's Early Independence Awards. The awards "provide an opportunity for exceptional junior scientists, who have already established a record of innovation and research productivity, to launch an independent research program."

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❸ Spradling lab postdoctoral associate **Megha Ghildiyal** received a three-year fellowship from the Jane Coffin Childs Memorial Fund to support her research. Postdoctoral associate **Don Fox** completed his studies at the lab and accepted a faculty position at Duke U.

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❹ Halpern lab graduate student **Courtney Akitake** received her Ph.D. from the Johns Hopkins U. in May and will commence postdoctoral work at The Johns Hopkins School of Medicine. Postdoctoral associate **Tagide deCarvalho** received an award from the NIH for her project on left-right asymmetry of the zebrafish brain. Graduate student **Vanessa Matos-Cruz** spoke at the Mid-Atlantic Zebrafish Meeting on May 20. Postdoctoral associate **Daniel Gorelick** spoke at the Gordon Research Seminar on Hormone Action in Development and Cancer and at the SDB Mid-Atlantic Regional Meeting. His talk was titled "Zebrafish Reporter Reveals Tissue-specific Differences in Estrogen Receptor Activation." This work was also featured in a "News and Views" article in *Endocrinology*. Postdoctoral associate **Lucilla Facchin** participated in the Gordon Research Conference "Neuroethology: Behavior, Evolution, and Neurobiology."

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Farber lab predoctoral fellow **Juliana Carten** received a three-year award from the NRSA to support a project on insulin's regulation of subcellular fatty acid metabolism in zebrafish. Visiting scientist **Øystein Saele** from the Natl. Inst. of Nutrition and Seafood Research in Bergen, Norway, is studying how phospholipids influence fat digestion in larval fish.

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New postdoctoral associates in the dept. were **SiewHui Low** and **Micah Webster** (Fan lab), **Jessica Otis** (Farber lab), **Haiyang Chen** and **Xiaobin Zheng** (Zheng lab), and **Sung Gook Cho** (MacPherson lab).

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Former staff associate **Philip Beachy** was awarded the Keio Medical Science Prize in recognition of his identification of *Hedgehog*. Beachy was a staff associate 1986-1988.

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❺ Embryology hosted meetings of the Carnegie Information Systems Group and all department business managers in May.

GEOPHYSICAL LABORATORY

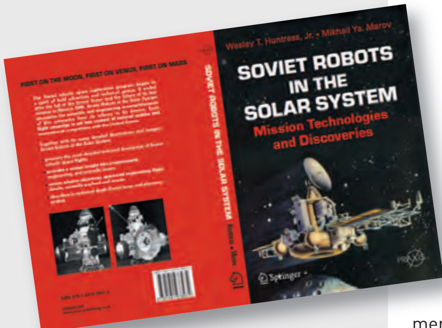
❻ **Russell Hemley** participated in the NIF Science Workshop held May 10-11 in Arlington, VA. On June 3 he presented an overview of HPCAT and led the tour group, which included U. Chicago president Robert J. Zimmer and ANL director Eric Isaacs. Secretary of Energy Steven Chu visited ANL to participate in the new Energy Sciences Building (ESB) groundbreaking ceremony. Hemley also

Timothy Strobel Receives Jamieson Award

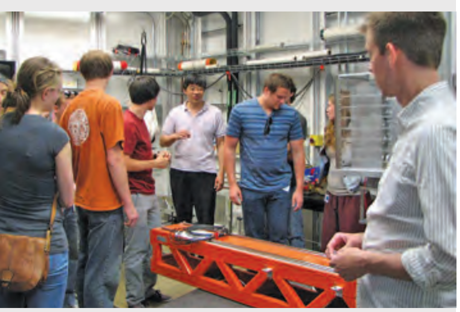
The Geophysical Laboratory's newest staff member, Timothy Strobel, was given the prestigious Jamieson Award on September 26, 2011, from the International Association for the Advancement of High Pressure Science and Technology in Mumbai, India. The Jamieson Award is given to a scientist who has just completed outstanding PhD thesis research or to an exceptional postdoctoral researcher. Strobel's research focuses on developing new hydrogen-based materials to meet our country's energy challenges.

❼ Bob Hazen took a field trip to Montana in September.

Image courtesy Margee J. Hazen



❽ Cover for Soviet Robots in the Solar System: Mission Technologies and Discoveries



❾ (Top) Beamline scientists **Changyong Park** and **Dmitry Popov** led NX School 2011 students in a high-pressure diffraction class June 23-24.

(Bottom) On June 30 undergraduate students visited HPCAT as part of their tour of Argonne. The students were participating in the Research Experience for Undergraduates.

On June 28 the attendees of the APS Topical Group on Shock Compression of Condensed Matter Conference toured HPCAT.

gave the opening plenary talk, "Chemistry of Planetary Gases, Liquids, and Ices in Extreme Environments," at the 242nd American Chemical Society National Meeting and Exposition Aug. 28 in Denver.

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❼ **Robert Hazen** was elected Counselor of the International Society for the Study of the Origin of Life and was nominated by George Mason U. for Virginia's 2012 Outstanding Faculty Award. He presented lectures on the Deep Carbon Observatory at U. Bremen and the Inst. de Physique du Globe,Paris; on complex evolving systems at the Brookings Inst. in Washington, DC, and the Museum of the Rockies in Bozeman, MT; on the origin of life at Montana State U. and George Mason U.; on mineral evolution at the U.S. Geological Survey, Menlo Park, CA, and the Goldschmidt Conference in Prague; and on chiral mineral surfaces at the Chirality 2011 conference in Liverpool.

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Ho-kwang (Dave) Mao received the first annual Earth and Environmental Sciences Alumni Achievement Award at U. Rochester on Sept. 9 and gave a talk, "Deep Earth Research in the 21st Century," to the faculty and students in the EES department. He gave a talk at the DOE EFRC Summit and Forum Meeting in DC on May 26. He also delivered a plenary talk at the Inst. of Earth Sciences, Academia Sinica, Taipei, on June 14; an invited talk at the Shanghai Synchrotron Radiation Facility High Pressure Workshop, Shanghai, on June 10; an invited talk at the 2011 DOE NNSA SSGF Annual Conference in DC July 22; and an invited talk at the Xiangshan Conference, Beijing, on Aug. 31.

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Douglas Rumble and former postdoc Ed Young (UCLA) received grants of $500,000 from NSF and $400,000 from DOE in addition to funds already awarded by the Sloan Foundation, Carnegie, UCLA, and Shell Development Corp. to build a high-resolution mass spectrometer to measure molecules of atmospheric and crustal gases.

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Bjørn Mysen gave two invited lectures during the Japanese Geoscience Union Meeting in Tokyo in May, an invited lecture at Tohoku U., Japan, in May, and a keynote lecture at the Goldschmidt Conference in Prague in Aug.

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Anat Shahar gave a talk at the Goldschmidt Conference in Prague in Aug.

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Muhetaer Aihaiti attended and presented a talk at the joint conference of the 20th IEEE International Symposium on Applications of Ferroelectrics and the International Symposium on Piezoresponse Force Microscopy & Nanoscale Phenomena in Polar Materials in Vancouver July 24-27.

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Adrian Villegas-Jimenez gave talks at the 43rd IUPAC World Chemistry Congress in San Juan, PR, and at the 2011 Goldschmidt Conference in Prague.

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Kadek Hemawan attended and presented a paper at the 38th International Conference on Plasma Science and 24th Symposium on Fusion Engineering. The conference was hosted by IEEE and held in Chicago on June 26-30.

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❽ Director Emeritus **Wes Huntress's** book, *Soviet Robots in the Solar System: Mission Technologies and Discoveries*, with coauthor Mikhail Marov has been published by Springer Praxis. The book chronicles the engineering and scientific accomplishments of the Soviet Union's robotic space exploration enterprise from its infancy to its demise.

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❾ High Pressure Collaborative Access Team (HPCAT)

Yoshio Kono received the Geological Society of Japan Masanori Sakuyama award for the study of the structure of the Earth's interior by elastic wave velocity measurement of rocks in Sept.

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Yuming Xiao spoke on "High Pressure X-ray Spectroscopy at HPCAT" at the 17th APS SCCM international conference in June in Chicago.

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High Pressure Synergetic Consortium (HPSynC)

Junyue Wang gave the invited talk "High Pressure X-ray Nano Tomography" at the 2011 NSLS/CFN joint users' meeting at Brookhaven National Laboratory on May 25.

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Summer intern **Daniel Shen** assisted the staff with the laser heating system project.

GLOBAL ECOLOGY

On July 22 **Chris Field** and Heidi Cullen were guests for an hour on the live NPR show *On Point with Tom Ashbrook*. They explained the relationship between weather and climate and answered a number of call-in questions.

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Ken Caldeira and his lab are filming short videos for YouTube that explain some of the key ideas from published scientific literature that might get overlooked. According to Caldeira, "Some people will view these and learn all they want to know about the topic. Others hopefully would proceed to read the underlying scientific articles." They are also making videos for a project called Near Zero, in which energy experts are interviewed.

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From June through Aug., **Greg Asner** and the Carnegie Airborne Observatory Team mapped remote areas of the western Amazon in Peru.

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Julia Pongratz of the Caldeira lab gave an invited talk at the 45th CMOS Congress (Canadian Meteorological and Oceanographic Society) in June.

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Luis Fernandez of the Field lab was interviewed on the Peruvian Cable News Network program *Rumbo Economico* on Feb. 28 on the widespread deforestation and environmental degradation in the Peruvian states of Madre de Dios and Puno. He received a grant from the U.S. State Dept. to serve as a plenary speaker at the Alternate Energy Sources and Sustainable Development conference at U. Carabobo in Valencia, Venezuela (Apr. 4-5) and gave a keynote presentation at Rafael Urdaneta U. School of Law in Maracaibo, Venezuela, on Apr. 7. He spoke about the use of renewable energy in reducing deforestation and carbon emissions. He was interviewed on Global TV's analysis program *Primicias* with Guido Briceño and talked about Ecología en Acción in Venezuela. Fernandez was profiled in an article in the Apr. 2011 issue of *Scientific American* about his research on the link between large-scale mercury emissions and ecosystem degradation in the Peruvian Amazon. His research on changes in Amazonian fish communities due to gold mining was referenced in an article ("A Mega-Dam Dilemma in the Amazon") in the Mar. 2011 issue *of Smithsonian Magazine*. Fernando visited the laboratory of Britaldo Filho Soares at the Federal U. Belo Horizonte (UFMG) in Brazil May 19-22. He was named a 2011 Scholar by the Aspen Institute and was invited to participate in the Aspen Environment Forum in Aspen, CO, May 30-June 2. Fernandez presented a paper, "Characterizing Mercury Emissions in Brazil and Peru," at the 10th International Conference on Mercury as a Global Pollutant in Halifax Jul. 24-29.

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Lee Anderegg joined the Berry lab on July 1. He was the recipient of the 2011 David M. Kennedy Honors Thesis Prize in Natural Sciences, which is awarded to graduating students who have written outstanding honors theses in the humanities, social sciences, natural sciences, and engineering.

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Arrivals: Katharine Ricke joined the Caldeira lab as a postdoc on Sept. 1.

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Departures: Alex Nees earned his master's degree from Stanford and left the Field lab for a job in private industry. **Lena Maatoug** and **Katharine Chadwick**, both interns in the Asner lab, left on Aug. 31. **Frank Merry**, a visiting investigator in the Asner lab, left on July 31.

Global Ecology welcomed **Anna Michalak** as its fifth faculty member. Her expertise is in statistical and geostatistical analysis of complex environmental phenomena, focusing on techniques for extracting the most information possible from limited data sets. Prior to joining Carnegie, Anna was the Frank and Brooke Transue Faculty Scholar and an associate professor at U. Michigan, with appointments in the Dept. of Civil and Environmental Engineering and the Dept. of Atmospheric, Oceanic, and Space Sciences. Joining Anna are a postdoc, **Vineet Yadav**, and three students: **Abhishek Chatterjee**, **Yuntao Zhou**, and **Yoichi Shiga.**


Anna Michalak


Vineet Yadav


Abhishek Chatterjee


Yuntao Zhou


Yoichi Shiga


⑩ Barry Madore


⑪ Luis Ho speaks at the "Cosmology Since Einstein" conference.


⑫ Eric Murphy

THE OBSERVATORIES

⑩ At the end of Aug. senior research associate **Barry Madore** went to the Harvard-Smithsonian Center for Astrophysics in Boston as a member of the Science Council to review the first year of operations of the Virtual Astronomical Observatory that is jointly funded by the NSF and NASA.

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⑪ Staff astronomer **Luis Ho** was an invited speaker at the conference "Cosmology Since Einstein" at the Inst. for Advanced Study, Hong Kong U. of Science and Technology.

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In July staff astronomer **Michael Rauch** attended the workshop "A Quarter Century of DLAs" in Ringberg, Germany. He also spent a month in July and Aug. as a Raymond and Beverly Sackler Distinguished Visitor at the Institute of Astronomy, U. Cambridge, where he gave a talk at the conference on "New Horizons for High Redshifts."

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Staff astronomer **Juna Kollmeier** gave a colloquium at U. Colorado at Boulder. She also gave an invited lecture to the students at Saddleback Coll. as part of their 2011 science lecture series. She was a session organizer at the Southern California Center for Galaxy Evolution inaugural meeting.

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⑫ Postdoctoral research associate **Eric Murphy** gave an invited colloquium in May at NRAO in Charlottesville, VA, titled "Star Formation in the Radio: Tuning to Higher Frequencies." He also gave an invited colloquium in May at UC-Davis on the same topic. He is a coauthor of "The Water Vapor Spectrum of APM 08279+5255." The research appears in the *Astrophysical Journal Letters*. Articles regarding the study are at the following Web sites: NASA.gov "Astronomers Find Largest, Most Distant Reservoir of Water" and at news.nationalgeographic "Black Hole Hosts Universe's Most Massive Water Cloud."

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Postdoctoral research associate **Rik Williams** presented his work on galaxies and the local intergalactic medium at the following conferences: "The Cosmic Odyssey of Baryons," June 20-24, Marseille, France, and "European Week of Astronomy and Space Science," July 4-8, St. Petersburg, Russia.

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Carnegie Fellow **Ian Roederer** gave a talk on "Primordial r-process Dispersion in Metal-poor Globular Clusters" at the Globular Cluster-Galaxy Connection 2 meeting in Santa Cruz, CA, in July. He was awarded the 2011 Outstanding Dissertation Award from U. Texas-Austin Graduate School and U. Co-op.

PLANT BIOLOGY

Wolf Frommer gave two talks at Toronto U. on Feb. 27-Mar. 1. He participated in the FOBI talks for the LIFE seminar series held at U. Copenhagen May 18 and traveled to China to give a talk at the Conference on Plant Metabolism and Crop Yield held in Qingdao June 28-July 3. He then traveled to Nanjing Agricultural U. to give talks on July 5. He also attended the 2011 FASEB Summer Research Conference on Glucose Transporters, Signaling, and Diabetes held Aug. 14-19 at Snowmass Village, CO, and gave a presentation titled "Novel Glucose Transporter Proteins from Plants and Mammals."

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On May 25 **Winslow Briggs** gave a talk at Mendel Biotechnology in Hayward, CA, on "The Recovery of Vegetation following a California Wildfire." He gave the same presentation on June 8 at Natl. Cheng Kung U., Tainan, Taiwan. On July 4 he gave a talk at the International Symposium on Photomorphogenesis held in Beijing and gave the concluding remarks on July 5. Together with **Bill Eisinger**, a visiting researcher, he presented a poster at the American Society of Plant Biologists meeting in Minneapolis in Aug. titled "Guard Cell Microtubule Bundling Correlates with Stomatal Aperture in *Arabidopsis*." **David Nelson**, a former postdoctoral fellow in his lab, gave a minisymposium talk there Aug. 10.

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Arthur Grossman attended the Keystone Meeting held in Singapore and on Mar. 3 presented the talk "The Photoautotrophic and Heterotrophic Production of Algal Biofuels." On Mar. 18 he gave a talk on "Discovery of Physiological Diversity in the Hot Springs" at Tel Aviv U. He gave a talk at Hebrew U. in Jerusalem on Mar. 25. On Mar. 25 he presented a seminar at N. M. Friedrich Schiller Universität in Jena, Germany, titled "Light Driven Reactions in *Chlamydomonas*, Probing the Function of GreenCut Proteins in *Chlamydomonas*." Mar. 30 he was at Technion U., Israel, and talked about "How Photosynthetic Organisms Sense and Respond to Sulfur Deprivation." On Apr. 5 he was at the Weizmann Inst. for Sciences, Israel, to give a similar talk. On Apr. 7 he returned to Hebrew U. to give the presentation "Algal Biofuels: The Reality of the Situation." On June 15 he helped guide the meeting on "Understanding the Coral Endosymbiosis" at the Hopkins Marine Station in Monterey, CA, and on June 22 he gave a seminar there. On July 2 he attended the Second International Conference on Plant Metabolism in Qingdao, China, and presented a symposium. On July 12-16 he attended the Phycological Society of America Annual Meeting in Seattle and led a symposium on the development of algae for biofuel production. He also gave a symposium talk. Grossman gave the symposium talk at the American Society of Plant Biologists held Aug. 6 in Minneapolis titled "Dissecting the Function of Green Lineage Proteins in Photosynthesis." On Aug. 15 he attended the Karles Conference in Washington, DC, and gave a talk, "Discussion of Synthetic Biology in Plants and Algae with Respect to Biofuel Generation."

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David Ehrhardt is a reviewing editor at *Science*. He gave the talk "Imaging of *Arabidopsis* Cytoskeleton" at the Society for Developmental Biology Annual Meeting held in Chicago on July 23. On Apr. 16-21 he attended the Royal Society Conference on Botanical Microscopy 2011 held in Wageningen, Netherlands, and gave the talk,"Molecular "Dynamics Underlying Plant Cell Morphogenesis."

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Kathryn Barton gave a lecture in the "ADVANCE Distinguished Lecture" series at Kansas State U. on Apr. 14 on "Stem Cells in Plants."

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Eva Huala, TAIR director, attended the GO Consortium Meeting held in Los Angeles May 19-21. She gave two talks at the Phenotype Ontologies Research Coordination Network meeting on June 1-4. She also gave a presentation at the 22nd International Conference on *Arabidopsis* Research held on June 22-25 in Madison, WI. She gave a presentation at the Carnegie Intern Seminar Series July 1, "TAIR—Introduction to a Plant Genomics Database."

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In June **Devaki Bhaya** attended the National Academy and Keck Futures Initiative (NAKFI) Synthetic Biology meeting in Chicago to discuss progress and how NAKFI grants have helped to establish collaborations, generate new publications, and enable follow-up funding. In Apr. she was the invited speaker for a symposium at Virginia Polytechnic Institute and State U.

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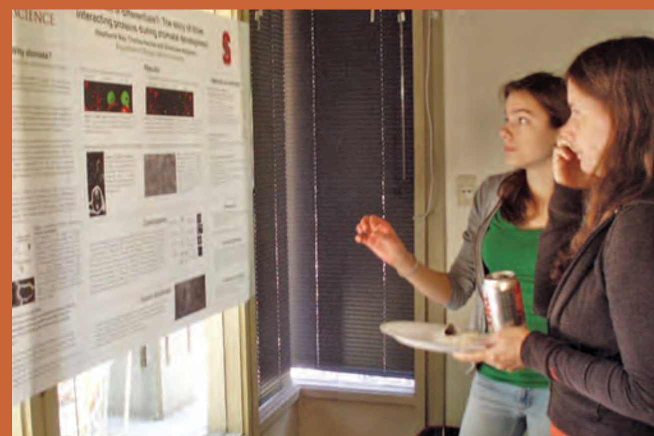
From the end of May through Aug. the dept. had a very successful summer intern program, welcoming interns from high schools and undergraduate students from various colleges and universities. Participants were **Caryn Johansen**, **Clare Gill**, **Daniel Hsiung**, **I. Lin**, **Leanna Racine**, **Tara Chandran**, **Jordan Haarsma**, **Laura Houille**, **Jay Kim**, **Rick Kim**, **Brandon Araki**, **Andrew Prior**, **Hilary Vance**, **Bryant Im**, **Alyssa Bagadion**, **Nicholas Goldman**, and **Matthew Wolski**. The intern program wrapped up with a luncheon poster session.



Participants study posters at the 2011 Plant Biology intern poster session.

Philippe Lamesch and **Donghui Li**, TAIR group members, presented the talk "TwiTAIR: What's Happening at TAIR Right Now" at the 22nd International Conference on *Arabidopsis* Research held June 22-25 in Madison, WI.

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Bob Muller, lead curator of the TAIR group, gave a presentation to the High School Visit Program held May 16 at the dept. titled "Computers and Genomics: How TAIR Makes Plant Genomics Data Available on the Web."

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Postdoctoral research associate **Brenda Reinhart** in the Barton lab was selected to give a talk at the Internatl. *Arabidopsis* Meeting in Madison, WI, titled "Expanding the Genetic Pathway for Polarity in *Arabidopsis* Leaf Development."

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Kate Dreher, TAIR curator, spoke at the Plant Biology 2011-American Society of Plant Biologists Conference held in Minneapolis on Aug. 6-10.

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TAIR curator **Tanya Berardini** attended the GO Consortium Meeting in Los Angeles May 19-21. She also spoke at the annual meeting of the American Society of Plant Biologists held Aug. 6-10 in Minneapolis.

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Wenqiang Yang, a postdoctoral research associate in the Grossman lab, attended the 1st World Congress of Marine Biotechnology held in Dalian, China, on Apr. 24-30.

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13 **Arrivals:** Staff Scientist **José Dinneny** arrived from Singapore on June 28 to open his new lab. Joining the lab are predoctoral students **Lina Duan**, arriving on Aug. 1, and **Yun Bao**, arriving on Aug. 11, both from the Temasek Life Sciences Laboratory at Natl. U. of Singapore. Also joining the Dinneny lab from Singapore is lab technician **Xueliang Wei**. Visiting TOYOBO Biotechnology Foundation Fellow **Masayoshi Nakamura** joined the Ehrhardt lab on Apr.1 from Nara Inst. of Technology. Carnegie Fellow **Mia Tereshima** arrived from Westfälische Wilhems-Universität, Münster, Germany, on July 1 to start her new position in the Jonikas lab. **Weronika Patena** arrived May 16 from UCSF to start as a lab technician in that lab. Postdoctoral research associate **Davide Sosso** arrived from École Normale Supérieure de Lyon at the Frommer lab on May 15 as did laboratory technician **Shruti Manoj Kumar** from Santa Clara U. on June 14. Laboratory technician **Adam Longhurst** joined the Barton lab on July 11 from UC-Santa Cruz. Postdoctoral research associate **Megan Bergkessel** joined the Bhaya lab on July 16. **Heather Cartwright** arrived from Stowers Inst. for Medical Research in Kansas City on Aug. 15 as director of core imaging. Senior software developer **David Huang** joined the TAIR group on Aug. 22. **John Griffin** arrived on Aug. 1 to start as facilities and operations manager for Plant Biology and Global Ecology.

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Jessica Warren, formerly a postdoc at Carnegie's Dept. of Terrestrial Magnetism and currently an assistant professor in Stanford's Dept. of Geological and Environmental Sciences, is collaborating with Carnegie's Dept. of Plant Biology on electron microscopy. Until now, Plant Biology's scanning electron microscope has been primarily used to investigate the structure and growth patterns of plants. Warren's lab is fitting the microscope with an electron backscatter diffraction detector to allow Warren to study the micro "anatomy" of thin sections from rock, which will be useful for understanding how the rocks formed.

Image courtesy Jessica Warren

⓭ José Dinneny

⓮ Sean Solomon

⓯ Alan Boss

⓰ David James (left) and Matt Fouch (right) in the field

⓱ Diana Roman

⓲ Alycia Weinberger

Departures: Postdoctoral research associate **Nabila Aboulaich** left the Frommer lab on May 31 and on July 31 postdoctoral research associate **Clara Bermejo-Herrero** left for a position in the private sector. Carnegie Fellow **David Nelson** left the Briggs lab on June 30 for a position at U. Georgia. Postdoctoral research fellow **Allision Phillips** left the Evans lab on June 3 for a position at Wisconsin Lutheran Coll. in Milwaukee. The Barton lab bade farewell to two departing lab members: Carnegie Fellow **Brenda Reinhart** left for Switzerland on July 15 and lab technician **Nicole Newell** left on July 22 to start a position at Florida State U. Postdoctoral research associate **Susanne Wisen** departed the Bhaya lab on July 8. Visiting graduate student **Yaqi Hao** from the Wang lab returned to her home institution in China on July 9. Postdoctoral research associate **Chang hun You** left the Rhee lab for a new position. Graduate student **Blaise Hamel** graduated from Stanford U. in June and departed the Grossman lab.

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Paul Sterbentz, facilities and operations manager for Plant Biology and Global Ecology, retired on Aug. 31. A farewell party attended by personnel of Plant Biology and Global Ecology was held on Aug. 24. He plans to travel with his wife, Laura.

TERRESTRIAL MAGNETISM

⓮ In June **Sean Solomon** participated in a news conference on early results from MESSENGER at NASA Headquarters. In Aug. he chaired a meeting of the MESSENGER Science Team hosted by U. Michigan in Ann Arbor. In Sept. he led a MESSENGER Science Team delegation to the 3rd Joint MESSENGER-BepiColombo Workshop held in Kyoto and gave seminars at UC-Berkeley and the Muséum national d'Histoire naturelle in Paris.

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⓯ In July **Alan Boss** discussed the Carnegie Astrometric Planet Search (APS) Program at the Origins 2011 International Astrobiology Conference in Montpellier, France. That same month, he chaired a meeting of the Astrophysics Subcommittee of the NASA Advisory Council (NAC) at NASA Headquarters in Washington, DC. He also lectured on planet-formation theories and the relevance of microlensing planets at the Sagan Summer Workshop at Caltech in Pasadena. In Aug. Boss presented the APS Letter Report to a meeting of the NAC Science Committee at NASA Ames Research Center and attended a meeting of the Kepler science team at the SETI Inst., both in Mountain View, CA. Also in Aug. he spoke about particle trajectories in gravitationally unstable disks at the annual meeting of the Meteoritical Society, held in Greenwich, UK.

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In June **Rick Carlson** presented an invited talk at the COMPRES mineral physics workshop in Williamsburg, VA. In July he gave a keynote presentation at the International Union of Geodesy and Geophysics (IUGG) General Assembly in Melbourne, Australia. Also in July, he spent two weeks with Dmitri Ionov (Université Jean Monnet) in Mongolia sampling the young basaltic volcanic rocks and mantle xenoliths of the Hangay Plateau as part of an NSF-supported collaborative project to understand why this mid-plate region is so geologically active.

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⓰ In Sept. **Matt Fouch** hosted a small group of scientists at DTM to discuss recent results on the NSF-supported High Lava Plains (HLP) project. Also in attendance were Carlson (HLP project PI), **David James** (HLP co-PI), and former DTM fellows Maureen Long (now at Yale U.) and Lara Wagner (UNC-Chapel Hill). Also in Sept., Fouch represented the EarthScope program at the NSF Natural Hazards Showcase on Capitol Hill.

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In June **Erik Hauri** presented a keynote lecture at a NASA workshop on "A Wet vs. Dry Moon" in Houston. In July Hauri and former GL fellow Elizabeth Cottrell, now of the Smithsonian Inst., organized a two-day workshop on satellite detection of volcanic degassing and space-based measurements of eruptive gas chemistry and flux.

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In June **Larry Nittler** gave a keynote address at the annual meeting of the American Society for Mass Spectrometry in Denver. He also participated that month in a NASA news conference on MESSENGER science results. In July he gave a seminar at NASA's Goddard Space Flight Center, and in Aug. he presented a paper at the annual meeting of the Meteoriticial Society and gave a public lecture on meteorites at the Greenwich Observatory.

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⓱ In July **Diana Roman** attended the IUGG General Assembly. She also spoke at a workshop on ground-based and remote sensing of volcanic unrest. In Sept. she carried out geophysical monitoring of marine outlet glacier dynamics in Vatnajökull, Iceland.

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⓲ **Alycia Weinberger** served as a science advisor to the US-Israel Binational Science Foundation at a panel meeting in Jerusalem in June. In July she was invited to speak at the Gordon Research Conference on Origins of Solar Systems at Mount Holyoke Coll.

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In June **Steven Golden** gave a poster at the Seismic Instrumentation Technology Symposium in Albuquerque.

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Postdoctoral fellow **Susan Benecchi** attended the NASA/JPL Planetary Science Summer School program in July. Her team completed a concept study for a mission to Venus, and she presented the results at a VEXAG meeting in Aug. In July and Sept. she observed Kuiper Belt objects with the Magellan and DuPont telescopes at Las Campanas Observatory.

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Visiting investigator **Eloïse Gaillou** presented a paper at the 62nd Diamond Conference at U. Warwick, UK, in July.

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In Aug. postdoctoral associate **Nick Moskovitz** spoke at the Meteoritical Society annual meeting.

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Intern **Katherine Ames** (U. Delaware) spent the summer reprocessing a portion of the High Lava Plains seismic dataset to detect and locate small earthquakes. She discovered a previously unknown swarm of small earthquakes that occurred in a rural area of eastern Oregon in May 2008.

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Attendees at the annual Goldschmidt Conference of the Geochemical Society and the European Association of Geochemistry held in Prague in Aug. were **Rick Carlson**, **Mary Horan**, and **Steve Shirey** and fellows **Eloïse Gaillou**, **Frances Jenner**, **Wendy Nelson**, and **Jonathan O'Neil**.

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Arrivals: MESSENGER Fellow **Paul Byrne** arrived in June. He received his Ph.D. from Trinity College, Dublin, in 2010. Carnegie Fellow **Frances Jenner** joined DTM in July. She received her Ph.D. from the Research School of Earth Sciences, Australian National U. Three new fellows arrived in Sept.: **Joleen Carlberg**, **Brian Jackson**, and **Liyan Tian**. **Joleen Carlberg**, the Vera Rubin Fellow, received her Ph.D. from UVA. **Brian Jackson**, who received his Ph.D. from U. Arizona in 2009, comes to us from NASA Goddard. **Liyan Tian** received her Ph.D. from UC-San Diego. New administrative assistant **Kasey Cunningham** arrived in Sept. She received her B.A. in communications and journalism from Shippensburg U. earlier this year. Visiting investigator and seismologist **Paul Rydelek** arrived in Aug. He will work on seismicity patterns prior to large earthquakes in Japan. In Sept. visiting investigator **Manuel Schilling** arrived from the Servicio Nacional de Geología y Minería, Departamento de Geología Regional in Chile to collaborate with **Rick Carlson**.

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Departures: Fellow **Evgenya Shkolnik** left in July to join the Lowell Observatory in Arizona. Hubble Fellow **Julio Chanamé** left in Sept. to take up an assistant professorship in the Dept. of Astronomy and Astrophysics at the Universidad Católica in Chile. Fellow **Wendy Nelson** left in Sept. for a postdoctoral fellowship at U. Houston. Fellow **Jonathan O'Neil** also left in Sept. for a year as a postdoctoral fellow at the Laboratoire Magmas et Volcans, Clermont-Ferrand, France, after which he will join the faculty at U. Ottawa. □

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Terrestrial Magnetism's Paul Johnson Remembers Carnegie

BY SHAUN J. HARDY

PAUL A. JOHNSON, an electronics research specialist and shop foreman with the Department of Terrestrial Magnetism (DTM) for 32 years, died at the age of 96 in January in Arizona. Johnson generously left a significant bequest to DTM's Merle Tuve Fund. The Merle A. Tuve Senior Fellowship Fund was established in 1995 to provide travel and research support for retired scientists or for scientists on sabbatical who arrange to do short-term research at DTM.

Johnson, a native of Jamestown, New York, worked in industry prior to coming to DTM as a temporary mechanic in early 1941. He initially helped assemble a 225-ton cyclotron, an accelerator used to produce radioisotopes for biomedical research. The job required expertise in electrical work, machine work, sheet-metal work, plumbing, and welding. Johnson distinguished himself and landed a permanent job within the year.

Paul Johnson (center) with Carnegie instrument shop foreman Bill Steiner (left) at Terrestrial Magnetism's 30-meter radio telescope site near La Plata, Argentina, in 1964. The telescope was built and operated in collaboration with the Argentine Institute of Radioastronomy.

In 1953 he nearly single-handedly designed and constructed the steel mount for DTM's first radio telescope, a 7.5-meter-diameter "Würzburg" radar antenna erected on the department's grounds in Washington, D.C. During the 1950s he participated in explosion seismology expeditions to the American West, Alaska, and South America, working with DTM scientists Merle Tuve, Howard Tatel, and Tom Aldrich. He returned to radio astronomy in the '60s, collaborating with design engineer (and boyhood friend) Everett Ecklund on the construction of dishes as large as 30 meters in Maryland and Argentina.

In 1968 Johnson was appointed shop manager and electronics research specialist—a position he held until he retired in 1973. At Johnson's retirement celebration, then-director Ellis Bolton praised him as "an endangered species fast disappearing from the American scene . . . a generalist of the first magnitude. I am daily astonished at his wisdom and his ability to do anything asked of him." □