SPECTRA

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2000

THE NEWSLETTER OF THE CARNEGIE INSTITUTION OF WASHINGTON

The Magellan I mirror travels on Interstate 10 in Arizona during the first leg of its journey.

INSIDE:

Extending the Frontiers of Science

Department of Plant Biology | Department of Terrestrial Magnetism | Department of Embryology | The Observatories | Geophysical Laboratory | CASE/ First Light

LETTER FROM THE CHAIRMAN

Tom Urban

A short time ago, laboratories recruited bright young minds and set them free to pursue their own research at their own pace. This approach created the technological world we live in now. From the way we communicate to what we eat, basic research from the past has improved our everyday lives.

Market forces and increased competition have changed the old approach to science, and not just in the commercial sector. As in industry, federally funded research is now evaluated on a regular basis. Performance is measured, results are stressed, and accountability is emphasized. For many institutions these pressures lead to real concerns. Are opportunities lost, especially in basic research, where serendipity should prevail and practical applications should not yet be a factor? Does trying to plan the progress of a project that is inherently fluid hamper insights? Faced with these questions, Carnegie finds itself in a unique position.

As an independent research organization, Carnegie frees its scientists from many of the constraints found at other institutions. For instance, our researchers have more time to pursue their science since Carnegie does not conduct formal classroom education. And we are less dependent on outside sources of funding because of the support from our endowment. Carnegie researchers are therefore more able to establish project goals that are not affected by the aims of others. This freedom also ensures that a risky idea can be explored and evolve without interference.

When science is allowed to flourish in this way, outcomes can be difficult to predict. But potentials multiply. And every once in a while, the payoff is a great new find.

Tom Urban

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The board of trustees met this past December at the Department of Terrestrial Magnetism in Washington, D.C. In addition to board business, the members experienced in situ science as they toured some dozen offices and labs in small groups. The trustees learned about specific research projects conducted at DTM on subjects ranging from distant astronomical objects to what goes on deep within the Earth. Shown (from left) touring the DTM laboratories are John Lively, trustee David Greenewalt, and Maxine Singer, with DTM scientists Selwyn Sacks and Alan Linde. Sacks is describing instrumentation for the installation of strainmeters more than a kilometer below the bottom of the Pacific Ocean off the coast of Japan. The work is part of a collaborative project with the Japan Marine Science and Technology Center and the University of Tokyo.

The directors' meeting was held at the Las Campanas Observatory in Chile last November. The Magellan I telescope provides a backdrop to the directors standing with Maxine Singer and Miguel Roth. From left are Chris Somerville, Sean Solomon, Maxine Singer, Miguel Roth, Wes Huntress, Allan Spradling, and Gus Oemler.

Edna (Ferrell) Haskins, wife of former Carnegie President and Trustee Emeritus Caryl P. Haskins, died January 30, 2000, in Westport, Connecticut, at the age of 88. She was born in Blyth, Northumberland, England. In 1933 she graduated with first-class honors in physical chemistry from Kings College, Durham University. She came to the U.S. and by 1937 had received her M.S. from Radcliffe. That same year she was also awarded her Ph.D. from Kings College. After receiving her doctorate, she joined the senior research and administrative staff in the British War Department and was the first woman to be appointed to the post of His Majesty's Inspector of Factories.

In 1940 Edna Ferrell returned to the U.S. and married Caryl P. Haskins, founder of Haskins Laboratories. She worked there as a scientist and administrator. She and her husband shared an interest in entomology and conducted important research in ant biology. She was a member of many organizations including the AAAS, the American Chemical Society, and the American Association of University Women. During the years her husband was president and trustee, Edna Haskins became an integral part of the Carnegie family.

Carnegie Atlas of Galaxies Debuts at the Museum of Natural History in New York

Over 70 images of galaxies from the classic *Carnegie Atlas of Galaxies* are now on display in the new Hall of the Universe at the American Museum of Natural History in New York. Observatories' Staff Member Emeritus Allan Sandage and John Bedke, formerly of Carnegie, compiled the original work. The hall opened in February 2000 and explores the content and evolution of the universe including galaxies, stars, and planets. Images from the atlas appear on a continuously running video.

Understanding the Power of New Materials

Huaxiang Fu and Ronald Cohen at the Geophysical Laboratory (GL) recently developed a theory that explains how a new class of piezoelectric materials has 10 times the power of similar substances and tested it via computer simulation. Piezoelectric materials are substances that convert mechanical energy, such as sound, into electricity, and vice versa. By understanding the origin of the giant effect of the new piezoelectrics, it will be easier to improve these materials, or discover others with even greater potential.

The scientists wrote in the January 20, 2000, issue of *Nature* that the new materials, discovered by Penn State University scientists, will revolutionize applications in acoustics including medical imaging, naval sonar, and hydrophones. The new substances are single crystals of PMN-PT and PZN-PT. The Penn State researchers discovered them using conventional experimental techniques. However, *why* the new piezoelectrics have 10 times the effect of previous substances was not known until Fu and Cohen's work.

Fu and Cohen's model uses first-principles computations, which work with fundamental physical quantities, such as nuclear charges, to obtain results. Fu and Cohen simulated the simpler material, barium titanate ($BaTiO_3$), under different applied electric fields. They found that the great response was from polarization rotation caused by the electric fields. Normally, fields are applied to the crystal along the direction of polarization and this produces small strains. The GL scientists' key finding was that when a field is applied obliquely to the polarization direction much larger strains result. They explain how these strains develop in their article.

Fu and Cohen's approach of using the computer and fundamental physics to predict the behavior of materials is relatively new to materials science. Such studies can give insights not obtainable by experiment because the theorist can examine the different causes of behavior via the model, rather than inferring the origins of a behavior indirectly. Materials theory is complementary to experimental studies. It can be used both to understand experimental observations and to make predictions that help guide experiments.

This branch of computational theory is also distinct from other models because experimental data input is not required.

The new materials that will result from these studies will form the active element in future generations of transducers that detect or generate acoustic waves. These devices are used medically in ultrasound, and in naval applications such as sonar and mine detection. The new piezoelectrics will greatly enhance the sensitivity, range, and resolution of these tools. Someday, doctors will be able to look into the body with such a high resolution that some types of exploratory surgery will not be necessary, and naval ships will be able to "see" farther and more clearly underwater.

New Link between Volcanoes, Climate, and Tectonics Believed to Exist on Planet Venus

Volcanic eruptions on Venus may have altered that planet's climate so dramatically that it caused tectonic stresses large enough to break rock. These stresses are believed to have deformed the most abundant type of terrain on the planet, called ridged plains, which cover about two-thirds of the entire surface. Scientists Sean C. Solomon, director of Carnegie's Department of Terrestrial Magnetism, and Mark Bullock and David Grinspoon of the Department of Space Studies at the Southwest Research Institute in Boulder, Colorado, reported their findings in the October 1, 1999, issue of *Science.*

Although Venus is frequently referred to as Earth's sister, there are fundamental differences between the two planets. Their climates and geological histories are two examples. On Earth, the mean surface temperature has changed over time by only a few degrees. In contrast, scientists now believe that the surface temperature on Venus may have varied by more than 100 K. Researchers know that the Earth's surface is the product of active plate tectonics, a process in which nearly rigid plates are in steady relative motion and interact principally at their boundaries. However, on Venus there is no evidence for global plate tectonics. So what gave rise to the tens of thousands of faults, known as wrinkle ridges, that deform the ridged plains? The evidence indicates that the formation of the wrinkle ridges was triggered by the volcanic eruptions that produced the vast plains. The plains-forming event, which occurred about 500 million years ago, was the largest episode of volcanism in the planet's known history. The estimated volume of this material is huge–at least 100 to 200 million cubic kilometers–enough to blanket the planet in a layer 500 meters thick. Evidence from impact craters suggests that the time it took from the emplacement of the lava flows to the deformation that produced the abundant wrinkles was quite short by geologic standards–less than 100 million years.

The scientists modeled the climatic consequences of the enormous eruption. They determined that a large change in surface temperature resulted, which was transferred to the interior and caused the thermal stress that created the ridges. The evidence for the mechanism behind these results begins with the fact that Venus is now and has long been a greenhouse cauldron. The surface temperature is about 740 K, and a global cloud layer and the thick atmosphere, consisting of 97% CO_2, keeps the heat contained. Water and SO_2 are important cloud constituents and affect the radiative balance of the atmosphere. According to the model, the release of additional water and sulfur gases to the atmosphere during the volcanic eruption enhanced the greenhouse effect and heated the planet by about 60 K over the next 100 million years. During this time, the hot surface rocks in turn heated the planet's interior. The heated material expanded in such a way that it compressed the surrounding area and created the abundant wrinkle ridges.

The model looked at the most significant episode of known volcanism on Venus. However, because so much of the planet's surface dates from this same period, the scientists know little about variations in climate before this event. According to Sean Solomon, lead author of the study, "What we are suggesting by extrapolation is that there may have been many large volcanic events in the history of Venus, each of which led to climate instabilities and to episodes of heating and cooling. Much of the history of faulting on Venus may be linked to climate change driven by major volcanic eruptions. This strong coupling among volcanism, climate, and global-scale deformation can account for many of the differences between Venus and Earth."

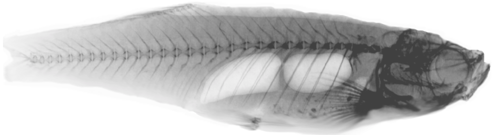
The Y2K Andes-Carnegie Summer School Wraps Up the Session in Stellar Style

The three groups of students attending the fourth Andes-Carnegie Summer School presented the results of their two weeks of work on February 25, 2000. The second-year college students studied astronomy, researched the literature, made observations, reduced their data, and presented their results.

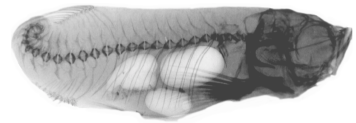
One group studied the light curve of Asteroid Penelope, suspected to be a binary asteroid. Their results indicated that this might indeed be the case. It was concluded that a campaign would be necessary, with six stations around the world, to get the coverage required for a Fourier analysis. The quality of the group's data was such, however, that their results will likely be published.

The second group presented distance measurements to globular clusters, using RR Lyrae variable stars—the results of George Preston's work. The third group determined the distance to the galaxy Centaurus A by determining the luminosity function of globular clusters. Their results compared very well with recently published studies that used much larger telescopes.

The Andes-Carnegie Summer School is a joint effort between Fundacion Andes, one of the most important private foundation in Chile, and Carnegie, with additional support from private donors. Gaspar Galaz is the school's coordinator.



It's in the Bones



Embryology's Marnie Halpern and postdoctoral fellow Shannon Fisher report in the December 1999 issue of *Nature Genetics* on the role of the gene *chordin* in bone development. How does a vertebrate go about producing bones in the first place? During growth of the skeleton, a class of transforming growth factor-beta proteins (called bone morphogenic proteins, or BMPs) stimulates mesenchymal cells. These cells are undifferentiated, but can give rise to specialized cells, which form cartilage (chondrocytes) and bone (osteoblasts). The chondrocytes and osteoblasts then deposit the cartilage and bone matrix and regulate the patterning of skeleton formation. Without BMPs, or with abnormal levels of BMPs, the stimulation goes awry and bone abnormalities result.

But what controls the BMPs? During a process called gastrulation, when the mesoderm and endoderm are formed, several proteins—including noggin and chordin—regulate extracellular activities of BMPs. They act as antagonists—inhibiting the effects of BMPs on cells of the gastrulating embryo. However, it has not been clear if chordin also influences BMP activity later, during formation of the skeleton.

In this study, Fisher and Halpern show that zebrafish lacking chordin expression have fin and caudal skeleton abnormalities. To determine when chordin activity is required for proper skeleton formation, the scientists took mutant zebrafish that lacked chordin expression and transiently "rescued" them by injecting the embryos with chordin messenger RNA. The injected RNA persisted through gastrulation, a period of about 10 hours, but was not present during later development. As expected, the injections counteracted the mutation during gastrulation. However, the fish also went on to develop normally patterned skeletons and normal bones, as was evident several weeks later. Thus, these experiments demonstrated that part of the pattern for the skeleton is already laid out during gastrulation, at the time when chordin functions to modulate BMP signals.

Halpern's laboratory uses the zebrafish as a model organism for studying vertebrate development. Zebrafish are ideal because they reproduce quickly and produce large numbers of offspring. In addition, the eggs are fertilized externally and are clear, allowing the researchers to view early development and identify mutant phenotypes. Dr. Fisher is now establishing her own laboratory, at the Johns Hopkins School of Medicine, and plans to undertake an x-ray screen on zebrafish to identify other genes, like *chordin*, that are involved in specifying and patterning adult bones.

Untangling Family Ties

Three classes of carbonaceous chondrite meteorites may be much more closely related than previously thought. The results of an Oxford University study, headed by former Geophysical Lab postdoc Ed Young, on the composition of the Allende meteorite were published in the November 12, 1999, issue of *Science*. Richard Ash, another former GL postdoc, Phil England (at Oxford), and GL's Doug Rumble co-authored the paper.

The scientists performed oxygen isotope analyses of the Allende meteorite and deciphered its mineral composition. Carbonaceous chondrites make up seven distinct groups of primitive meteorites; each has different characteristic ratios of oxygen isotopes and a different mineral composition. The Allende meteorite is a 4.6-billion-year-old CV-carbonaceous chondrite. Previous models indicated that the variations in mineral content among three classes of carbonaceous chondrites (CV, CM, and CI meteorites) that span the diversity found in all seven groups meant that they came from separate parent bodies with different origins and histories. The researchers show in this study, however, that the variations can be explained with one progenitor or several progenitors that originated and evolved in similar ways.

According to the new model, melting water ice percolated through a parent body via capillary action and altered the isotopic composition as it moved outward. Two zones separated by a distinctive front resulted, and each of these areas had a different mineral makeup. The scientists found that the three areas resemble the three classes of meteorites in both oxygen isotope ratio and mineralogy. This result suggests that the meteorites may have come from one parent body.

Meteorites represent the chemical evolution of the early solar system. Many have not undergone secondary alterations since their formation as the Earth and Moon have. These specimens thus provide a pristine record of this early formative era. Studies like this one will help advance our understanding of what went on as the solar system coalesced into what it is today.

The Planet Hunter

Paul Butler joined the DTM staff in August 1999. Since 1995, he and colleague Geoffrey Marcy of U.C. Berkeley have discovered two-thirds of the 33 planets thus far identified orbiting distant stars.

The fact that worlds exist outside our own solar system was the stuff of science fiction only a decade ago. Planet discoveries today, however, are happening with increasing frequency and are attracting a lot of attention. Last November, all the major newspapers and a host of TV networks picked up on the discovery of a distant planet passing directly in front of its star. This finding was pivotal to the field of planet hunting. Up to that point, the existence of all extrasolar planets had been inferred indirectly. The star named HD 209458 and its companion planet changed that and provided the astronomers with the boost they needed. The planet's orbital plane is edge-on to Earth, and this orientation allowed the scientists to detect the light of the star dim as the planet passed by in orbit. Marcy and Butler predicted the times when the planet would pass directly in front of the star on November 5, and these "transit" events were observed by Greg Henry (Tennessee State University) on November 7. In addition to confirming the existence of extrasolar planets, this event also allowed the absolute mass, diameter and density of an extrasolar planet to be determined for the first time.

The technology to image these far-off worlds does not yet exist. Instead, the scientists use the Doppler effect–a change in the frequency of light caused by an object's motion–to find their prey. Recently, Butler has contributed to articles in magazines such as *Astronomy* and *Natural History* that detail just how these "planet prospectors" do it. The key is that the gravitational field of a planet with a Jupiter-like mass affects its star. "Like an unruly poodle yanking its more massive owner on a leash, an orbiting planet gravitationally tugs the host star around in a small counter orbit," says Butler.

When the star moves toward Earth in response to the planet's tug, the light shifts toward the blue end of the spectrum. As the star moves away, the light is shifted to the red. These subtle shifts let the astronomers unravel the planet's orbit and determine its mass.

The current technology can only find giant planets like Jupiter and Saturn. Despite this limitation, the scientists have discovered some interesting patterns among the planet systems to date. Most of the planets move in highly elongated, eccentric orbits, not the nearly circular orbits that characterize our own solar system. These systems might have been affected by the gravitational pull of multiple Jupiter-mass companions. The only known system of multiple planets, discovered by Butler and Marcy in 1999, shows evidence for these kinds of gravitational perturbations. Marcy and Butler expect more multiple planet systems will emerge from their survey in the near future.

In the mid-1990s, the astronomers were interested in finding *any* extrasolar planet. Now, with 33 under their belt, they have raised the bar with ambitious plans. They want to discover smaller planets and solar systems like our own, determine what a typical planetary system is, and understand how all this evolved. With their proven rate of progress and advances in technology, there is no doubt the Butler and Marcy team will make huge strides toward these goals in the very near future.

$C0_2$ Has a Day in Congress

On October 6, 1999, Congress got a lesson on atmospheric gas. Chris Field of the Department of Plant Biology testified in Washington on the topic "Is $C0_2$ a pollutant, and does EPA have the power to regulate it?" Field's remarks focused on plant physiology and the physical processes related to $C0_2$ in the atmosphere. He instructed congressional committee members on four points: the necessity of atmospheric $C0_2$ to life on Earth; the dramatic increase of $C0_2$ over the last century due to human activities; the positive and negative effects of $C0_2$ increases; and the inability of an increase in plant growth to fully compensate for the problems associated with an increase in the gas.

Field began by explaining the photosynthetic process in plants and how it produces the oxygen necessary for life. He went on to describe the way scientists have systematically measured $C0_2$. The gas has been continuously monitored since 1958. Information from before that period comes from trapped bubbles in ice core samples. The combined data reveal a large increase in levels of the gas since the Industrial Revolution from fossil-fuel combustion and deforestation. Field went on to say that carbon dioxide from the burning of fossil fuel has a unique combination of carbon isotopes, so the origin of the recent increases of the gas is clearly identified. Interestingly, only about half of the carbon emitted remains in the atmosphere; the rest is stored in terrestrial and aquatic ecosystems. If it were not for these carbon stores, Field said, levels of atmospheric $C0_2$ would increase even faster.

The third part of Field's testimony outlined the positive and negative effects of $C0_2$ increases. For some important food crops, an increase in $C0_2$ means an increase in the plant's growth rate. However, he cautioned, this effect could have some undesirable consequences. For instance, some studies indicate that pests fed plant material grown under elevated levels of the gas eat more; thus an increase of $C0_2$ in the atmosphere could result in more crop losses. Some weeds also grow more in a $C0_2$–rich environment; this too could affect crop yields. Field also said that the link between global warming, increased precipitation, and increased $C0_2$ levels is becoming better understood. Recent models indicate that at a certain point, negative effects cancel out any beneficial effects on plant growth.

Although about half of the gas ends up in carbon stores on Earth, Field emphasized that it is unlikely that the storage rate will increase dramatically in the future to solve the problem. He ended his testimony with this conclusion: "Overall, increasing $C0_2$ is likely to cause serious problems, and it is extremely unlikely that the terrestrial uptake of it will be sufficient to prevent them unless the world's nations take additional steps to limit emissions."

A Burning Question

The Observatories' George Preston published a paper in the February 2000 *Publications of the Astronomical Society of the Pacific* that asks, "What are extremely metal-poor stars good for anyway?" Preston reviewed the past 30 years' research on these stars, looking at what might have been done better and, most interestingly, proposing what the future holds for this subject.

The very first stars were made of the Big Bang material–mostly hydrogen, some helium, minute traces of lithium, beryllium, and boron, and nothing else. Then, in this first generation of stars, the hydrogen burned into more helium and the helium to carbon. The process continued, producing stars with increasingly heavier elements–all the way up to bismuth and the radioactive elements–in processes known collectively as nucleosynthesis. The more massive stars lost mass gently at the ends of their lives, and some of their elements were recycled into space. The most massive stars exploded as supernovae; the debris emitted was used to form subsequent generations of stars. This process repeated itself, gradually enriching the heavy-element content of the universe. Extremely metal-poor stars (EMPs) are relics from those few very early generations of stars that formed in our Milky Way galaxy. Their signature is the virtual absence of elements heavier than helium. EMP stars comprise no more than one-tenth of a percent of the stars formed since the beginning of time. They are hard to find, but by examining the spectra of these rare bodies, scientists can get a glimpse into the chemical composition of the earliest phases of our galaxy.

The future of this field is being mapped out at Carnegie's Las Campanas observatory. Currently, Preston and Observatories' colleagues Andrew McWilliam, Ian Thompson and Steve Shectman use the Swope and du Pont telescopes to find metal-poor stars. The scientists use CCD photometry. Since many other varieties of stars can mimic the signature of EMPs, the team had to refine their search to eliminate the forgers. In 1999 the Carnegie team initiated GRISM spectroscopy (a GRISM is a special combination of diffraction Grating and pRISM used to analyze starlight) at the du Pont telescope, and this technology resulted in a first list of "bona fide" metal-poor stars.

In the next decade, the team will employ the new Magellan telescopes in their search for and high-resolution spectral analysis of these elusive bodies. Preston and others are hoping that their findings will offer more insight into the Milky Way's chemical infancy and answer questions about the creation and evolution of the chemical elements in the universe.

...In the News...In the News...In the News...

Findings from a report issued by the Union of Concerned Scientists and the Ecological Society of America on climate change in California attracted front-page coverage in the Golden State last November. Papers from the *Los Angeles Times* to the *San Francisco Examiner* covered the story. The report's senior author was **Christopher Field** of the Department of Plant Biology. The conclusion was that pressures from the rapidly growing population and effects from El Niño will change California's climate over this century. California winters are predicted to be wetter and warmer, while summers may become even drier and hotter. The researchers detailed the potential effects to both terrestrial and aquatic ecosystems.

The March 6, 2000, issue of *Business Week* magazine reported on a talk given by **Chris Somerville**, director of Plant Biology, at the recent AAAS meetings. The article highlighted Somerville and team's work using a jellyfish gene. The gene produces a fluorescent that the researchers use as a dye to trace the locations of plant genes, with unknown functions, in the mustard *Arabidopsis*.

The *Boston Globe* asked **Alan Boss** of the Department of Terrestrial Magnetism to comment on a new model that explains why Uranus and Neptune ended up at the edges of our solar system. The icy worlds started out much closer to the Sun, the study said, but were flung to the outer reaches by the gravitational forces from Jupiter. Boss remarked, "It's a radical idea…maybe we need a radical idea."

The January 7, 2000, issue of *Science* looked at the dog-eat-dog world of galactic collisions and mergers. Observatories' **François Schweizer** was quoted extensively in the article. When asked to speculate on how our solar system would be affected by a future collision between the Milky Way and the Andromeda galaxy, Schweizer said that the resulting supergalaxy would be home to many rocky worlds where "huge waves of civilizations may reach maturity nearly simultaneously."

MIRROR ON

The Steward Observatory Mirror Lab, underneath the football stadium at the University of Arizona, was home to the Magellan I mirror from the early 1990s.

It was homecoming weekend for the Arizona Wildcats–an auspicious time for the Magellan I mirror to begin its journey. The University of Arizona Steward Mirror Lab, directly beneath the school's football stadium, had been home to the mirror since it was first assembled beginning in the early 1990s. At last it was finished, packaged, and ready to go to its new home, the observatory at Las Campanas, Chile, 6,000 miles away.

On Sunday, November 7, 1999, the morning after the big football game, the mirror cell, with a dummy test mirror inside, was loaded onto a gleaming air-ride Piazza Trucking trailer. The giant cell was then cocooned in a tarp and parked overnight on the apron outside the mirror lab.

Truck drivers, pilot-car personnel, Matt Johns (far right), and a film crew are briefed by the Arizona Highway Patrol just before departure.

At 6:00 the following morning, the 9.5-ton, 6.5-meter primary mirror, in its 14.5-ton protective transport box, was brought out of the lab and prepped. Air shocks were pumped up, and thermocouples to monitor the internal temperature were examined. The container was then gently loaded onto another blindingly clean air-ride truck. Another load, with mirror supports and ventilation system parts, made up the third component of the cargo.

The transport crew secured the loads, and everyone waited for instructions from the Arizona Highway Patrol, which governs large loads such as these traveling in Arizona.

The Plan

There were three trucks, their drivers, and a mechanic from Piazza Trucking to haul the cargo. Four pilot cars would make sure that other traffic was kept at a safe distance: two would accompany the mirror and two the cell. Two chase cars were also included. One was driven alternately by Matt Johns, Magellan project manager, and Charlie Hull, Magellan mechanical engineer, who shared responsibility for riding with the mirror. The other car contained a video crew who documented the U.S. portion of the trip. Four police escort cars–two for each of the large loads–completed the pack. Just before 9:00 a.m., the police briefed everyone about the departure and the trip. The convoy would proceed through the streets of Tucson to Interstate 10, which it would follow west all the way to the California border. At specific intervals the Arizona police would hand off the escort duties to officers from different districts until the convoy reached the border around 3:00 p.m. The loads would be parked in an undisclosed secure area until midnight, at which time the California Highway Patrol would take over for the trip to the Port of Los Angeles.

The first leg–Arizona

At 9:00 a.m. the convoy left the lab. The mirror, sandwiched between the pilot cars and following the police escort, was the first wide load to negotiate the streets to I-10. Carnegie's Charlie Hull was in the cab. Matt Johns's car was next, followed by the cell load with a similar array of lighted escort vehicles. The camera crew bolted toward the highway by a different route so that they could get close-ups of the mirror leaving Tucson. Once on the interstate, both Magellan loads reached highway speeds,

The mirror heads toward California on Interstate 10.

stopping occasionally to allow traffic to pass.

Late in the morning, about 40 miles south of Phoenix, the plans abruptly changed. The police decided that instead of risking congested traffic around Phoenix, the convoy should deviate west along Highway 8, then go north at Gila Bend along Highway 85 to rejoin I-10 at Buckeye. Matt, driving between the two big loads, wasn't informed of the change until the trucks actually made the turnoff. By the time he was able to call and inform the camera crew, they had long passed Highway 8 in a race ahead of the mirror for scenic oncoming shots. That communication from Matt was unexpectedly the last one for the day. The cell phones, it turned out, didn't cover the area between Phoenix and Los Angeles and the camera crew was not equipped with the CBs the convoy used to communicate.

Route 85, a two-lane road through desert, presented its own set of challenges. Oncoming traffic was frequently forced to pull off to allow the huge, fragile loads to pass. And the convoy faced a surprise at Gila Bend. A miscommunication with the officer slotted to take over the escort duties forced the convoy to wait about an hour and a half for the handoff. The camera crew waited too–except that they sat along I-10 at Buckeye having no idea where the convoy was.

The mirror (left) and cell (right) are ready to be loaded onto the Columbus Line ship at the Port of Los Angeles.

The original plan called for the convoy to reach the California border by 3:00 p.m. At 1:50, unable to raise the convoy by cell phone, the camera crew decided to drive to the border anyway to find out where the pack would park until midnight. At about 4:00 p.m., with a tip from the California police and a CB broadcast by a helpful truck driver, the film crew finally located the convoy. It had just reached an empty weigh station a few miles back to the east.

By 5:00 p.m. all parties were reunited. They dined on fast food, found out what had happened, and were informed of another change in plans. Instead of waiting until midnight, they were told, the convoy would cross the Arizona-California border at 8:00 p.m.

The drivers, the mechanic, Matt, Charlie, and the film crew sat with the cargo until 7:45, at which time the film crew went to the border to set up for the night crossing. They waited and waited. This time the problem was one of the pilot cars. The driver had locked her keys in the car while at the weigh station. The assembled team was held hostage for another hour and a half waiting for emergency road service. Finally, at 9:30 p.m., with flashing lights and appropriate fanfare the mirror, the cell, and the container with their many attendants crossed the border.

California

After the border crossing, the camera crew sped ahead toward the Port of Los Angeles. The trucks and escorts whizzed along until about 2:00 a.m. Just outside of Los Angeles a fog descended that was so thick visibility was reduced to the car ahead. This was the most anxious part of the trip for Matt, who by this point was riding in the truck with the mirror. Around 3:00 on the morning of November 9, the trucks finally and safely reached the port. The loads were securely stored, and by 4:00 a.m. everyone was free to leave and go to sleep.

Midday Friday, November 12, the truck drivers, Matt, Charlie, and the film crew reassembled at the port. The cell was unwrapped, the air shocks for the mirror were pumped up again, and thermocouples that had been monitoring the temperature changes inside the protective box were checked and removed. All pieces were inspected, and all was in order. Between 1:30 and 2:30 p.m. the three Magellan containers were carefully loaded onto the Columbus Line ship. Matt Johns and marine surveyors hired by Carnegie witnessed the loading and examined

The container, with mirror supports and other equipment, is inspected at the Chilean port of Coquimbo.

the tie-down. The vessel then departed on its 16-day voyage to the port of Coquimbo, Chile.

Chile

Shortly after the Columbus Line vessel left the Port of Los Angeles, Matt Johns departed for Chile. In Chile, the arrangements for receiving the shipment at the port and getting it to the observatory were the responsibility of a team of Magellan personnel headed by Peter de Jonge and seconded by Frank Perez. They went over every detail from getting the cargo out of the port and clearing customs to housing the mirror and cell at the Magellan compound. Matt joined them before the ship's arrival and, with Miguel Roth, director of the observatory at Las Campanas, would provide the team

In Coquimbo, Matt Johns (white jacket) and Peter de Jonge (brown jacket) monitor the placement of the mirror on a rare air-ride trailer.

with additional support when needed.

Like many such shipments, the arrival date for the Magellan cargo was fluid: it could be anytime within a two-to three-day window. On November 26, the team was informed that there was a strike at the docks in Iquique, Chile, and that the

At dawn the convoy, with mirror in front, leaves the La Serena area.

shipment would probably not arrive until very late on the 28th–a Sunday.

The Chilean plan

Coquimbo is a special port of call for the Columbus Line–it is not one of their normal stops. Unlike the Port of Los Angeles, the Chilean port does not have dock cranes large enough to handle cargo as heavy as the Magellan pieces. The ship's cranes, therefore, were needed for the unloading.

The transport crew changes the flat tire on the truck carrying the mirror cell about 20 kilometers from Coquimbo.

Another difference for this leg of the journey was in the truck transport. In the United States, air-ride trailers are common; in Chile they're rare. But the team was able to locate one such truck to haul the mirror. The escort situation also differed. From the port of Coquimbo to the top of the observatory mountain, the trucks would be escorted by a vehicle from the Department of Public Works and a car driven by the trucking company's owner. A single police car would be available; it would ride in front of the convoy to make sure oncoming traffic pulled over to the side of the road. As in the United States, different districts would assume responsibility for the convoy when it was in their territory. This time there were to be four Carnegie cars. One would contain contingency equipment. Matt would drive another near the front of the convoy, while Frank Perez would bring up the rear. Miguel would supervise a Chilean video crew from one car; and the crew would drive another to shoot the trip from various vantage points. Peter was to ride in the cab of the truck with the mirror, and communication among all the vehicles was to be via hand-held radio.

In Chile, the carabineros, or highway patrol, are in charge of overseeing the transportation of oversize truckloads–and there are plenty of them since the region has a large mining industry. To avoid traffic in Coquimbo and La Serena, the officials asked that the convoy leave very early in the morning. Once the pack cleared the narrow town streets, the carabineros would make sure that traffic stayed to the side of the Pan American Highway–Route 5–all the way to the turnoff leading to the observatory. The total trip was expected to take between 12 and 14 hours and cover 175 kilometers (109 miles).

The 14.5-ton transport box was first used to transport the Multiple Mirror Telescope's (MMT) 6.5-meter mirror and will be used again to transport Magellan II in 2002. The box was developed jointly by the University of Arizona, MMT and Magellan. Mirror transport boxes are usually designed for a specific mirror. Because the MMT and Magellan mirrors are practically identical they can use the same box. The box protects the cargo against shock, changes in temperature, severe weather, and accidental damage. It can safely withstand 4 g with merely 30 millimeters of mirror motion.

To insulate the fragile cargo from motion, the box has a three-layer shock-absorbing system. An outer frame is secured to the truck or ship. An inner frame, isolated from the outer frame's vibrations, supports the mirror. Finally, air-filled shock absorbers attach the mirror to the inner frame, providing a final layer of protection. Impact sensors document the mirror's motion.

The ship comes in

The dock strike having been resolved, the ship was expected to arrive very early Monday morning, November 29th. Frank Perez watched for the vessel's arrival. It entered the port of Coquimbo shortly after 3:00 a.m. By 5:00 a.m., the Carnegie group had gathered at the dock, along with customs and agriculture representatives, stevedores, the local media, and curious Observatories' personnel.

Peter and Matt checked the cargo; all appeared to be well. The container with the mirror supports was first out of the hold at 6:30 a.m. It was opened and inspected at the dock. One pallet carrying a rack of

The convoy makes a detour around an almost-completed bridge on the Pan American Highway.

supports had been damaged, and some of the supports seemed to have shifted during the transport. (Later the crew found that 6 units of the 104 had to be rebuilt before they could be installed in the telescope.)

Frank and Matt then checked the mirror box still in the hold. They looked at the impact sensors and pumped up the shocks. The cell was then lifted off the ship onto its truck. By 8:00 a.m. the mirror had been moved and was fully secured onto the air-ride trailer. By this time,

Miguel Roth (left) listens as the carabineros discuss several buses that violated the order to pull over.

morning was well under way. It was too late to make the trip out of town with two oversize loads, so the container shipment went to Las Campanas alone that day. The team left the port and made final arrangements for the trip to Las Campanas with the remaining two large loads.

To the mountain

Staging for the mirror and cell started at 3:30 the following morning, Tuesday, November 30. To comply with the wishes of the carabineros, the convoy left the port around 4:00 a.m. The troop crept over a pothole-ridden road that was barely wide enough for the two wide loads. It took almost an hour to get to the intersection with the Pan American Highway, a distance that normally takes less than five minutes.

The first portion north along the Pan American Highway consisted of a split road: there were two lanes in each direction. However, just over a kilometer away was a one-lane bridge that had to be crossed. The bridge on the north side of the highway–the side leading to the observatory–was too narrow for the cargo. The bridge on the south side–the wrong side of the road–was newer and just wide enough. At first the carabineros were unsure where and when the convoy would be able to get onto the correct side of the road after it had crossed the wider bridge. Radio contact among the parties was thick with tension. As the convoy waited, the police drove north to investigate the options. They made their determination, and at 5:10 a.m. traffic on the south side of the highway was waved over to the shoulder. The convoy turned on the wrong side of the highway and went over the bridge at a walking pace–a pace that was to punctuate the journey several more times en route to Las Campanas.

Soon thereafter, the carabineros ushered the trucks to the correct side of the highway and the convoy sped up to 10-15 kilometers per hour. By 6:00 a.m. the final obstacle to leaving the La Serena area–another marginally wide bridge–had been overcome. Just moments later, though, the radio crackled with news: the cell truck had had a flat. The convoy limped along for a few more kilometers and pulled into a rest stop to wait for the first carabinero handoff scheduled for 9:30, and to change the tire.

The 20-kilometer journey thus far had taken two and a half hours. The 12 to 14 hours that was estimated for the entire trip was beginning to look too optimistic. The wait at the rest stop was, however, fortuitously timed, because it gave the crew time to change the truck tire safely and the team time to discuss the best

The mirror wends its way up toward the observatory.

plans for their next hurdle: yet another bridge. This one was still under construction, although it was supposed to have been completed in time for the mirror's trip. At 9:07 a.m. the convoy left the rest stop. By 9:30 a.m., on a pitted construction road, the group slowly made the detour around the almost-completed bridge.

For the next two hours the trip was relatively uneventful. Carabineros waved traffic off the two-lane highway in 20-kilometer increments and the convoy moved on. Cars and trucks kept backing up behind Frank's vehicle as they snaked through the dry, twisty, mountainous terrain in a line stretching as far as the eye could see.

The mirror reached Las Campanas late November 30 and was parked at the base of the final summit overnight.

Over the best parts of the highway the precious cargo averaged between 15 and 20 km/h–a good 75 kilometers per hour slower than the standard speed the U.S. convoy attained. Around 11:30 a.m., near Caleta Hornos the calm was shattered. Three buses broke rank and tried to weave south through the truck pack, jeopardizing the safety of the bus passengers and sending even more adrenaline through the veins of the Carnegie principals. Disobeying the carabineros is a severe violation in

The last leg of the journey to the telescope was successfully completed the morning of December 1, 1999.

Chile. The culprits were caught and ticketed; they would later be issued steep fines. Traffic was allowed to pass at about noon, and the journey proceeded smoothly and relatively quickly (at times as fast as 20 km/h) until about 3:00 p.m.

Out of the blue, everyone heard Frank's surprised and angry voice over the airwaves. A car had just raced by, nearly hitting him, and had then swerved in between the trucks and sped to the front of the line. The driver, as it happened, was a captain of the carabineros, and he was very unhappy with the traffic backup. In no uncertain terms he told the officers ahead to let the traffic pass. A few minutes later the convoy pulled over, the backup disappeared, and pulse rates subsided.

By 4:00 p.m. the group finally reached the turnoff to Las Campanas. Although traffic would not be an issue for the rest of the trip, the recently improved road was still rough and progress was slow. Matt and others checked the box before the final leg of the journey. All the vehicles except the trucks, the truck owner's car, and the attending equipment car were asked to go on ahead so that the fragile loads could contend with the road without interference. Peter was still in the cab of the mirror truck.

At 4:45 p.m. the abbreviated convoy started the 28-kilometer haul up the mountain. They had to drive even more delicately over the rough dirt road because of its steep grade. For long periods the progress was at a slow walking speed. Darkness started to fall and it was clear that, at such a pace, the loads would not get to the telescope by dark. Matt, Peter, and Frank discussed the situation over the radio and decided to park the trucks at the base of the final summit for the night.

At 9:45 p.m.–17 3/4 hours after leaving Coquimbo–the wide loads, with their exhausted entourage, arrived at the Las Campanas compound. The mirror and cell would wait until morning to make the final short trek to the telescope.

The next day was December 1, 23 days after the mirror had started on its voyage. By 7:30 a.m., Matt was already busy checking the mirror supports in the container. Frank and Peter, meanwhile, conferred with the crane operator and others on the details for lifting the mirror. Initial preparations took until lunchtime. At 1:30 p.m., the crew carefully lined the crane up with the bridge that joins the Magellan I telescope dome to the auxiliary building. After several test runs and endless moments of precise fine-tuning, the mirror was finally brought aloft. It swayed in the wind for a brief moment. Then

Twenty-three days after the mirror left the Arizona lab, it reached its new home, the Magellan I telescope.

very, very gently the priceless package touched down on the bridge. At 4:00 p.m. the Magellan I mirror was finally home.

TRUSTEES

John Diebold is heading a project on the impact of public policies on entrepreneurial start-ups in biotech and IT comparing the UK and the U.S.

William Rutter will receive the 2000 Bower Award in Business Leadership presented by the Franklin Institute. The award honors the tremendous contributions made by Dr. Rutter to the biotechnology industry.

Frank Press (above) has been appointed an Ordinary Member of the Pontifical Academy of Sciences (the Vatican).

ADMINISTRATION

Maxine Singer attended the 25th anniversary of the Asilomar Conference on Recombinant DNA Molecules. She also was the cospeaker at the inaugural CIW/Virginia Tech public forum, "Reflections on Science" speaking on the challenge of human genetic testing. An article she wrote entitled "Shaping the Future for Women in Science" was reprinted in the February 2000 newsletter of the American Society for Cell Biology.

Wes Huntress, director of GL, gave a lecture to the administrative staff on Feb. 29. His talk was entitled "Astrochemistry: how outer space cooks."

Sharon Bassin is the new Assistant to the President. She replaces **Susan Vasquez**, who retired in December after 33 years at Carnegie. **Sue Humphreys** is the new secretary to the President, and **Darla Keefer** comes to P Street as secretary to the Director of Administration and Finance. **Claire Hardy** works as an assistant in the External Affairs office.

EMBRYOLOGY

Alejandro Sánchez Alvarado and Tatjana Piotrowski became parents to baby boy Sebastian Sánchez Piotrowski. Alejandro was invited to give a talk by the Developmental Biology Training Grant (U. Utah). He addressed the molecular biology program at the Sloan Kettering Institute in New York City. He was a plenary speaker on the Stem Cell and Medicine Forum sponsored by the Japan Association for the Advancement of Research Cooperation in Oiso, Japan. He also addressed the Medical Research Council-sponsored regeneration cooperative at University College in London.

Sofia Robb joined the Sánchez Alvarado lab as a research assistant.

Bill Kelly (Fire lab) has taken a position as Assistant Professor in the Biology Department at Emory U.

Judith Yanowitz (Princeton U.) joined the Fire lab to study development in the nematode *C. elegans.*

Alexander Tsvetkov will be a Visiting Investigator in the Gall lab. He is from the Institute of Cytology, Academy of Sciences, in St. Petersburg, Russia. He will be working on the molecular composition of the cell nucleus in insects.

Allan Spradling gave the keynote address at the Keystone Symposium on Stem Cells.

Toshi Kai (Osaka U.) has joined the Spradling lab to study the regulation of ribosome production in *Drosophila* eggs.

Yixian Zheng received the 1999 Junior Award of the American Society for Cell Biology, given to recognize outstanding scientific contributions.

Postdoctoral fellows **Shannon Fisher** and **Steve Farber** started new jobs. Shannon Fisher is Assistant Professor, Department of Medicine, Johns Hopkins Medical School, and Steve Farber is Assistant Professor, of Microbiology & Immunology, Thomas Jefferson U.

Valarie Bertoglio-Miller and husband, Aaron Bertoglio, welcomed their baby boy, Colin Adler Bertoglio, on Dec. 15, 1999.

Marnie Halpern and **Michelle Macurak** returned to the Federal U. of Rio de Janeiro, Brazil to teach in the two-week UNESCO and CNRS-sponsored course on developmental biology (Nov. 22-Dec. 3). Former Carnegie Staff Scientist Nipam Patel (U. Chicago) joined them this year.

Mandy Chestnutt (U. Maryland) joined the Halpern laboratory in Jan. as an animal-care technician.

Danny Lee, a former Johns Hopkins undergraduate and recipient of the Provost's award for his senior thesis research while in the Halpern lab, was a first-year M.D. Ph.D. student at Washington U. when he was killed in an automobile accident with three of his classmates on Jan. 17. A fund to support undergraduate research in the biomedical sciences has been established at Johns Hopkins U. in his honor.

Richard Grill, biological photographer at the department from 1949 to 1986, died this winter. At Carnegie, he produced high-quality photographs of embryos, and thus was an important participant in the days of anatomical embryology.

OBSERVATORIES

George Preston gave a lecture on the nature of blue metal-poor stars during a visit to U. Virginia in Feb.

Patrick McCarthy presented a paper at the annual meeting of the American Astronomical Society. He also hosted a weeklong joint workshop with the Institute of Astronomy (Cambridge, UK) regarding a large area near-IR faint galaxy survey. **Ron Marzke**, **Gus Oemler**, **Eric Persson**, **Martin Beckett**, **Hsiao-Wen Chen**, **Lin Yan**, and **Alan Dressler** participated along with 12 other astronomers from Cambridge, U. Toronto, and Caltech. In Dec., McCarthy participated in a design review for the Wide Field Camera 3 for the Hubble Space Telescope (HST).

John Mulchaey has finished writing a review article for the Annual Reviews of Astronomy and Astrophysics. He has also been awarded telescope time on two new x-ray telescopes: Chandra and XMM.

In November, **Luis Ho** convened in Cupertino, CA with an advisory board for optical-infrared instrumentation for Taiwan's Academica Sinica Institute of Astronomy and Astrophysics. He was also in Baltimore at the Space Telescope Science Institute to serve on HST's Cycle 9 proposal review panel in Nov. He was invited for an extended visit in Dec. to work at the Very Large Array, where he also gave a colloquium entitled "Supermassive black holes and accretion power in the nearby universe."

Lin Yan gave a colloqium at the NRAO at Socorro, NM, on Jan. 21. The title of the talk was "Results from the NICMOS/HST parallel imaging and spectroscopic survey."

Wendy Freedman was featured in the March issue of *Astronomy* in an article titled "Hubble Warrior." Wendy gave an invited review at a meeting on birth and evolution of galaxies in Tokyo in Nov. She participated in the organization of two workshops on the interface between particle physics and cosmology. The outcome of the meetings was a briefing book prepared for NASA, the NSF, and DOE. She has recently been nominated to the AURA Board.

Ron Marzke and his wife, Heidi Waterfield, are the proud parents of Cassandra Marzke born Nov. 26, 1999.

The Observatories staff continues to grow. **Doug Burns** joined the Observatories as business manager on Feb. 1. He replaces **Georgina Nichols,** who moved to another position in Los Angeles. **Linda Schweizer** is the new assistant director of External Affairs. **Hsiao-Wen Chen** is a new postdoctoral associate working with Pat McCarthy. **Vince Kowal** is the new machinist working with the IMACS instrumentation group. **Joe Vijil** joined the purchasing group in the fall.

PLANT BIOLOGY

In Jan. **Shauna Somerville** presented a lecture at a symposium at Wageningen Agricultural U., Netherlands. In Feb. she gave a lecture at the Plant Genome symposium at AAAS annual meeting in Washington, D.C.

Chris Somerville also presented a talk, "Genomic tools for plant cell biology" at the AAAS meeting. In Jan., he presented a seminar at a conference in The Hague, Netherlands, organized by U.S. Ambassador Cynthia Schneider, to engage European policy makers and the press in a discussion about issues associated with plant and animal biotechnology.

Winslow Briggs made two trips to the Orient last fall. The first was to Japan and Korea, with seminars at Tokyo Metropolitan U., the Hitachi Advanced Research Laboratory, Kyoto U., Osaka City U., and the Pohang Inst. Technology and U. Ulsan in Korea. The second trip was to Taiwan to give a seminar and review the molecular biology program at the Academia Sinica. The seminars discussed phototropin. Winslow was an invited speaker at the Gordon Conference on Sensory Transduction in Microorganisms in Jan.

Arthur Grossman presented two seminars at UCLA in Feb. He also presented a seminar at the Western Photosynthesis Congress, Jan. 6-9, in Asilomar, CA. In Nov., Arthur attended the Japanese Congress on Genomics and presented a lecture. In Oct. he presented two seminars at Washington U. He attended the European Workshop on the Molecular Biology of Cyanobacteria in Berlin, Germany, in Sept. and presented a lecture. He then traveled to Montecatini Terme, Italy, to attend the European Phycology Congress and presented a plenary lecture. Arthur is also serving on the editorial board of *Plant and Cell Physiology*.

In Oct. he was awarded a $3.3 million grant by the NSF for his project "Analyses of the *Chlamydomonas reinhardtii* genome: a model, unicellular system for analyzing gene function and regulation in vascular plants."

Recent postdoctoral arrivals in the Shauna Somerville lab include **Fredrik Sterky** (U. Stockholm), **Jeremy Gollub** (U. California, San Francisco), and **Dario Bonetta** (U. Toronto). Visiting researchers in the lab include **Aurelie Andre** (U. Lyon, France) and **Ken Keegstra** (Michigan State U.).

Chris Somerville added staff to The *Arabidopsis thaliana* Information Resource (TAIR) lab with the arrival of **Seung Rhee**, director, **Eva Huala**, head curator, and **Margarita Hernandez-Garcia** and **Leonore Reiser**, curators.

Hideki Takahashi, a visiting researcher from Japan, will be working in Arthur Grossman's lab. **Akiko Takahashi** joined the Grossman lab as a lab technician, filling the position vacated by **Pinky Amin** in Dec.

Roheena Kamyar joined Dave Ehrhardt's lab as a technician.

Benjamin Poulter joined Chris Field's lab as a field technician.

Danielle Werck returned to Strasbourg after spending a sabbatical year in Chris Somerville's lab.

TERRESTRIAL MAGNETISM

Erik Hauri is to receive the H. G. Houtermans Medal of the European Association of Geochemistry in Sept. at the Goldschmidt Conference, to be held at Oxford U. The medal is given every few years to an outstanding young scientist for his or her overall contribution to geochemistry.

George Wetherill will be the recipient of the J. Lawrence Smith Medal and Prize of the National Academy of Sciences. The award recognizes recent original and meritorious investigations in meteoritics.

Sean Solomon was the 1999 recipient of the G. K. Gilbert Award from the Geological Society of America (GSA). This award is presented annually for outstanding contributions to the solution of fundamental problems in planetary geology. Solomon served on the External Review Committee of the Scripps Inst. of Oceanography and the Physical and Mathematical Sciences Review Committee of Brown U. in Oct. He gave seminars at U. Maryland in Oct. and at Caltech in Feb.

Former postdoctoral fellow **Graham Pearson** was the recipient of the Lindgren Award of the Society of Economic Geologists for his work on diamonds. The award was presented in Oct. at the GSA meeting, with **Steve Shirey** delivering the citation.

Alan Boss and **Paul Silver** were elected Fellows of the American Geophysical Union (AGU) in Feb.

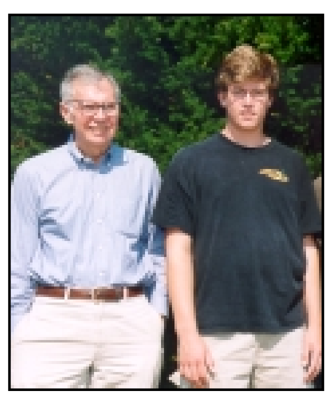
David James was an invited speaker at the Royal Astronomical Society/Geological Society meeting, "Archean Crust and Mantle: From Mantle Dynamics to Conditions for Early Life," in London on Feb. 10-11.

Rick Carlson gave invited talks at U. Michigan in Jan., and at a symposium in Feb. held in honor of the 60th birthday of his Ph.D. advisor, Guenter Lugmair, now director of the cosmochemistry group at the Max-Planck-Institut für Chemie.

Paul Silver organized a workshop (Oct. 3-5) at Snowbird, UT, where 125 participants considered a proposal for the Plate Boundary Observatory, an array of strain instruments that would measure plate-boundary deformation throughout western North America. Also attending the workshop were **Alan Linde**, **Selwyn Sacks**, and **Sean Solomon**.

New postdoctoral fellows include Italian National Research Council Postdoctoral Fellow **Chiara Petrone** (left), who received her Ph.D. from U. Florence, and is working on the Sr, Nd, and Pb isotopic analysis of igneous rocks of the Mexican Volcanic Belt. Postdoc **Rob Swaters** (center), who completed his Ph.D. at the Kapteyn Astronomical Inst., Groningen U., is continuing his work on motions within galaxies. Postdoc **Fenglin Niu** (right) arrived from the Earthquake Research Institute, U. Tokyo, where he received his Ph.D. and was later a Japan Society for the Promotion of Science Postdoctoral Fellow. He is continuing his work on the seismic structure of the mantle transition zone.

Alan Boss reviewed the formation of planets at the conference, "Science with the Atacama Large Millimeter Array," held in P Street's Elihu Root Hall in Oct. He lectured on the origins of stars and planets in the Space Science Lecture Series at NASA headquarters, and spoke about gas giant planet formation at the Center for Star Formation Studies Workshop at NASA's Ames Research Center. He gave seminars at the Institute for Astronomy in HI and at SUNY, Stony Brook, in Oct., at U. New Mexico and at the Harvard-Smithsonian Center for Astrophysics in Dec., and at U. Arizona in Feb. In Jan., he gave the overview talk at the



Research intern **Patrick Kelly** was one of 40 finalists selected from among 1,517 applicants in the Intel Science Talent Search. Kelly, a senior at Sidwell Friends High School in Washington, D.C., studied the colors and magnitudes of galaxies with DTM advisors **Dan Kelson,** and **John Graham** with whom he is shown.

Euroconference on disks, planetesimals, and planets, held on Tenerife, Canary Islands. In Feb., he spoke about extrasolar planets to the Astrobiology Oversight Committee at NASA headquarters and at the New York Center for Studies on the Origins of Life in Albany.

DTM attendees at the Fall AGU meeting included **Rick Carlson**, **Erik Hauri**, **David James**, **Selwyn Sacks**, **Steve Shirey**, **Paul Silver**, **Sean Solomon**, **Fouad Tera**, and postdoctoral fellows **Laurie Benton**, **Matthew Fouch**, **Philip Janney**, and **Lianxing Wen**.

Carnegie Fellow **Karl Kehm** arrived in Feb. after completing his Ph.D. at Washington U. At DTM, he plans to make use of multicollector plasma mass spectrometers to make high-resolution measurements of the stable isotopes of mercury.

Jeffrey Ryan (U. South Florida, Tampa), began an appointment as a visiting investigator in Jan. Dr. Ryan will spend a six-month sabbatical at DTM measuring the B and Li isotopic ratios in lavas from Mt. Erebus, Antarctica, as well as in selected achondritic meteorites. A Carnegie Fellow at DTM from 1989 to 1991, he was selected as the 1999 Florida Professor of the Year by the Carnegie Foundation for the Advancement of Teaching and the Council for the Advancement and Support of Education.

Predoctoral fellow **Gordon Irvine** arrived in Jan. to work with Rick Carlson on the analysis of mantle xenoliths from the Kaapvaal and Slave cratons.

Alberto Saal, a postdoctoral fellow at Lamont-Doherty Earth Observatory, arrived in Feb. to work with Erik Hauri on melt inclusions from midocean ridge basalts (MORBs) using the electron and ion microprobes. He will also be working with Rick Carlson and Steve Shirey on osmium isotopes in MORBs.

NASA postdoctoral associate **Patrick McGovern** has moved to a staff position at the Lunar and Planetary Institute.

Hubble Fellow **Michael Regan** took a position as assistant astronomer at the Space Telescope Science Institute in Jan.

John Lynch returned to his position as Program Director for Antarctic Aeronomy and Astrophysics at the National Science Foundation (NSF) in Oct., after spending a year at DTM as a Visiting Investigator.

Recent visitors at DTM include **Vickie Bennett** (Australian National U.), **James King** (U. Botswana, Gaborone), and predoctoral fellows **Jane Goré** (U. Zimbabwe) and **Teresia Nguuri** (U. Witwatersrand).

Postdoctoral fellow **Laurie Benton** and David Mitcheltree are the parents of Jack Benton Mitcheltree, born Oct. 9 and weighing 7 lbs. 11 oz.

DTM postdoctoral associate Emilie Hooft (center left) and technician Randy Kuehnel (center right) along with U. Oregon student Chris Bryant (left) are inspecting data collected by a portable seismograph on the island of San Cristobal in the Galápagos Islands. This is one of ten stations installed throughout the island group in collaboration with U. Oregon and the Inst. Geofísico, Escuela Politécnica Nacional, Ecuador. This effort is part of a one-year passive seismic experiment to determine the mantle structure of the Galápagos hotspot. Also shown standing is Ramon Zavala, captain of the *Española,* who along with Estacion Científica Darwin, has provided support and transportation to each of the remote islands.

DTM/GL

Ian Mac Gregor, a Senior Science Associate for Geoscience Education at the NSF, has been appointed a Senior Associate at Carnegie. He is working on the development of geoscience curricula.

Visiting Investigator **Harry Green** (U. California, Riverside) arrived Feb. 1. On sabbatical leave, Dr. Green is Vice Chancellor for Research and Professor of Geology and Geophysics. While here, he plans to work with colleagues on the mechanics of deep-focus earthquakes, studies of rock deformation, and phase transitions in minerals.

GEOPHYSICAL LABORATORY

Robert Hazen presented lectures at Columbia U., the Smithsonian, the Union Theological Seminary, and presented invited papers at the GSA and AGU meetings. Dr. Hazen served on AGU's Panel on Teaching Evolution, which has revised the Union's policy statement on the evolution/creationism debate. His recent book, *The Diamond Makers* (Cambridge University Press, 1999), has been nominated for the Rhone-Poulenc Science Writing Prize, to be awarded by the Royal Society in London in May.

Bjørn Mysen served on the organizing committee for the conference, "Processes and Consequences of Deep Subduction," held in Verbania, Italy, Sept. 5-11. This conference was cosponsored by GL, the Institute for the Study of the Earth's Interior (Japan), and the Bayerisches Geoinstitut (Germany). Dr. Mysen spent Sept. and part of Oct. at the Mineralogical Museum, U. Oslo. While there, he gave an invited lecture entitled "Silicate-water interaction at high pressure and temperature."

H. S. Yoder, Jr., lectured at the Learning in Retirement Institute (George Mason U.) in Sept. on minerals in humans and medicines. The mineral exhibit he prepared is now on display at GL.

Wes Huntress was the recipient of the 1999 Masursky Award. This honor is given by the American Astronomical Society for meritorious service in the field of planetary sciences. He also received the Caltech Management Association's Excellence in Management Award for 1999.

Albert Coleman (Yale U.) has been appointed a predoctoral associate and is working with Drs. Fogel and Rumble on oxygen isotope geochemistry of seawater phosphate.

Przemyslaw Dera (Adam Mickiewicz U., Poland) has been appointed a postdoctoral fellow. Dr. Dera recently completed his Ph.D. work as a predoctoral fellow at GL. As a postdoctoral fellow, he plans to work with Charlie Prewitt and Bob Hazen on the high-pressure crystallography of organic molecular crystals.

Yang Ding (Johns Hopkins U.) has been appointed a predoctoral associate and will be working with Charles Prewitt on phase transitions of the bornite-digenite series.

Holger Hellwig (U. Cologne) has been appointed a postdoctoral research associate. Dr. Hellwig will work with Rus Hemley and others to do experiments on a new nonlinear optics facility that has been donated by Prof. William Daniels (U. Delaware).

Monika Koch-Müeller (Technische U. Berlin) has been appointed a postdoctoral research associate. She is working with Yingwei Fei in research on crystal chemistry of rock-forming solid solutions at high pressure.

Matthew McCarthy (U. Washington) has been appointed a postdoctoral fellow. He plans to work with Marilyn Fogel and the astrobiology group by applying his expertise in chemical oceanography, expanding his perspective by considering the effects of hydrothermal environments on dissolved organic matter.

Jacob Waldbauer is working as a technician for Marilyn Fogel. Jake has been a high school and college intern at GL where he worked with George Cody. He is currently a junior at Dartmouth.

Does your grant have a component to help elementary or high school education?

If so, CASE can help. Currently, the Carnegie Academy for Science Education is participating in programs such as the joint DTM/GL Astrobiology Institute and Sean Solomon's MESSENGER mission to Mercury. These and other projects are excellent venues to help teachers teach science better and inspire students to learn. If your grant has or needs a science education component, contact the CASE staff to learn how at CASE@pst.ciw.edu, or call 202-939-1135 and speak with Linda Feinberg.

In Brief...

Matthew Wooller (U. Wales, Swansea) has been appointed a postdoctoral research associate and is working with Marilyn Fogel. Wooller and Fogel, in collaboration with the Smithsonian Environmental Research Center, will be working on a biocomplexity project studying mangrove ecology in Belize and Florida.

Susan Ziegler has taken a tenure-track assistant professor position as a microbial ecologist at U. Arkansas. **Glenn L. J. Piercey**, who was a Research Assistant at GL working with Marilyn Fogel, has taken a new position as a biologist, also at U. Arkansas. Sue and Glenn became officially engaged on the trip down South and will be married in July.

Ikuo Kushiro received the Roebling Medal, the highest honor given by the Mineralogical Society of America (MSA), for exemplary studies in experimental petrology. He started his experimental work on basalts with Hatten Yoder and Frank Schairer as a postdoc at GL in 1962.

Staff Member **Yingwei Fei** received the 1999 MSA Award. He was presented the award in Denver at the October GSA meeting. **Charlie Prewitt** served as the citationist.

Ronald Cohen was coorganizer of the Aspen Center of Physics Winter Workshop on Fundamental Physics of Ferroelectrics held Feb. 13-20 in Aspen, CO. The workshop was sponsored by CIW and the Office of Naval Research.

Spectra is now on the Web!

You can now read *Spectra* on the Carnegie Web site at www.ciw.edu. If you would prefer to receive *Spectra* electronically, please e-mail Ellen Carpenter at ecarpenter@pst.ciw.edu. Suggestions on how we can improve the newsletter can be e-mailed to Tina McDowell at tmcdowell@pst.ciw.edu.

Edwin Hubble to appear on a U.S. postage stamp

On April 10, 2000, a new stamp commemorating Carnegie's own Edwin P. Hubble will be officially released. There will be celebrations on both coasts. The Observatories is hosting a reception for 300 guests at Santa Barbara Street. Allan Sandage, who worked with Hubble, and Observatories' Director Gus Oemler, will speak. The Honorable Tirso del Junco, Chairman, Board of Governors of the U. S. Postal Service, will also address the crowd. Special commemorative stamped envelopes will be offered for sale, and there will be an originally designed first-day cancellation stamp used by the local post office that day.

An event is also scheduled at the Goddard Space Flight Center in Maryland. The East Coast event will celebrate both Hubble and the Hubble Space Telescope. Daniel Goldin, NASA's Administrator, and Senator Barbara Mikulski of Maryland are featured speakers along with Carnegie astronomer Alan Dressler. Maxine F. Singer, Carnegie President, will join in the unveiling of the new stamps during the Goddard ceremony.

WANTED:
Carnegie Artifacts and Stories

Margee Hazen is seeking stories and artifacts associated with Carnegie for the upcoming centennial exhibit. If you have any ideas or interesting artifacts to display, please contact her at mhazen@pst.ciw.edu.