Flashback: LPIB Celebrates its 100th Issue

Lunar and Planetary Information

BULLETIN

Lunar and Planetary Institute — Universities Space Research Association

November 2004
Issue 100

www.lpi.usra.edu/lpib

Lunar and Planetary Information Bulletin

Looking Back over the Past 30 Years!

This year we celebrate not only the 100th issue of the *Lunar and Planetary Information Bulletin*, but also our 30th year of publication. Given that your current editors were still in high school and junior high respectively when the first issue was published in March, 1974, we thought you would enjoy revisiting past issues and seeing what interesting stories have been been published over the years. The results were both entertaining and surprising. Some stories were funny, others wistful, and others sad. We hope that you will enjoy this glance from past issues as we look forward to future explorations of Mars, Saturn, and beyond.

Paul Schenk, Scientific Editor
Renee Dotson, Production Editor

Opening and Display of Apollo 16 Surface Samplers — Issue 4, November 1974

Final preparations are being made in the [JSC] Curatorial Facility to open and inspect the Apollo 16 Lunar Surface Samplers. These were devices used to obtain samples by pressing a cloth surface (one a velvet pile, the other a teflonized fiberglass) against the lunar surface. Colin Pillinger (Bristol, England), in conjunction with the Curator, has designed the apparatus and procedures to open and inspect these samples.
[*Editor's note: A velvet pile? On the Moon?*]

Lunar Polar Orbiter — Announcement of Opportunity — Issue 6, June 1975

The National Aeronautics and Space Administration has issued an Announcement of Opportunity (AO) providing information and guildeines for prospective investigators who are interested in participating in the Lunar Polar Orbiter (LPO) mission, tentatively planned for a June-1980 launch. The LPO will be a cost-limited geochemical, geophysical, and geological mission capable of extending to the entire Moon, orbital and surface science results obtained from previous lunar missions, especially Apollo. Because of the applicability of LPO objectives and concepts to the exploration of planetary bodies, this mission may serve as a scientific prototype for similar missions to Mars and to Mercury.
[*Editor's note: We're still waiting . . .*]

Proposals Sought for 1979 Uranus Mission — Issue 6, June 1975

NASA is announcing an opportunity for participation in scientific investigations to be performed on the Mariner Jupiter/Uranus 1979 (MJU79) mission which is under consideration for launch during the 1979 launch opportunity. This is a unique opportunity to explore the planet Uranus and generally extend our exploration of the early solar system . . . Deadline for proposals is 2 September 1975.
[*Editors' note: A good idea, it ultimately was reabsorbed into the Voyager mission.*]

NASA Announcements of Opportunity — Issue 10, October 1976

AO-OSS-3-76 is a solicitation of proposals for scientific investigations of Jupiter. The overall scientific objects of this mission are to conduct comprehensive investigations of the Jovian system by making in situ and remote measurements of the planet, its environment, and its satellites . . . In the proposed mission, a single launch in 1981/1982 would carry a spacecraft to Jupiter which would consist of an atmosphere-entry probe and a long-lived orbiter. Proposals for the probe investigations are due November 1, 1976 and for the orbiter investigations, December 1.
[*Editors' note: This ultimately became Galileo, which completed its mission only 28 years later*!]

Study Project Begins at LSI — Issue 11, January 1977

An LSI [Lunar Science Institute, the original name of the Lunar and Planetary Institute] study project entitled "Basaltic Volcanism in the Terrestrial Planets: A Pilot Program in Comparative Planetology," has been funded by NASA and is now underway. The project is focused on study of one particular planetary process, basaltic volcanism, on all the terrestrial planets.
[*Editor's note: This highly successful study project culminated in publication of* Basaltic Volcanism on the Terrestrial Planets, *published in 1981 by Pergamon Press in collaboration with the Lunar and Planetary Institute*.]

In Memoriam — Issue 13, July 1977

Dr. Wernher von Braun
March 23, 1912–June 17, 1977

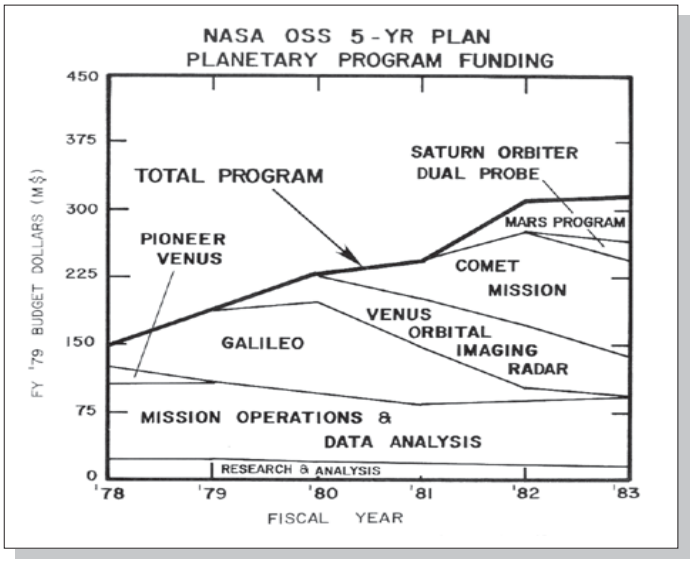
LSI Summer Intern Program — Issue 14, December 1977

In the spring of 1977, the Lunar Science Institute offered students nationwide an opportunity to work closely with scientists active in lunar and planetary research. Out of about 75 highly qualified applications, ten undergraduate or newly graduated students were chosen to take part in the Summer Intern Program.
[*Editor's note: This successful program is now entering its 29th year. In 2004, 11 interns were selected out of 115 applicants. The report of the 2004 Summer Intern Conference is included elsewhere in this issue.*]

NASA's 5 YEAR PLAN

— Issue 16, June 1978

[*Editor's note: The best-laid plans . . .*]

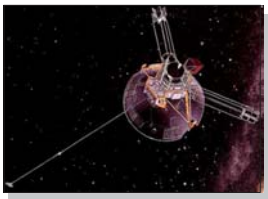


FUTURE LUNAR EXPLORATION

— Issue 17, November 1978

There is no doubt that lunar exploration will resume and that large scale missions will again take place. They may be manned, unmanned, or both. They may or may not be tied to such practical projects as lunar mining, or to large permanent bases. You may well have considered what scientific questions you would like to see attacked at that time, and what might be the best experiments for the purpose. Our plan [Jim Arnold and David Criswell] is to discuss them at a special session of the Tenth Lunar and Planetary Science Conference. It seems a good time to start some new thinking.

[*Editor's note: We're still waiting . . .*]



WE MADE IT!

— Issue 20, September 1979

With the help of national television (PBS) thousands of pioneers arrived at the legendary world of Saturn on Saturday, September 1, 1979. We reached our destination after a 2 billion mile journey aboard the spacecraft Pioneer 11.

[*Editor's note: Cassini arrived in Saturn orbit in July of this year, only 25 years later!*]

GALILEO PROJECT UP-DATE

— Issue 20, May 1979

Plans for the Galileo Project are proceeding on schedule even though some problems in scheduling may result from the problems occurring with the Space Shuttle. Delays in the Shuttle may cause the Galileo mission to be set back to 1984 and it may be necessary to split the launch into two parts, one to orbit Jupiter and the second to drop a probe into the giant planet's turbulent atmosphere.

INTERNATIONAL COMET MISSION: ANNOUNCEMENT OF OPPORTUNITY

— Issue 21, December 1979

The National Aeronautics and Space Administration (NASA) and the European Space Agency (ESA) jointly announce an opportunity for participation in an exploratory comet mission. It is currently contemplated that, if authorized, this mission will be launched in 1985 and will include a rendezvous with a short period comet and a flyby of a second, more active, comet for comparative measurements. Primary candidates under consideration at this time include comet Tempel 2 and comet Halley.

IN MEMORY: THOMAS R. MCGETCHIN

— Issue 21, December 1979

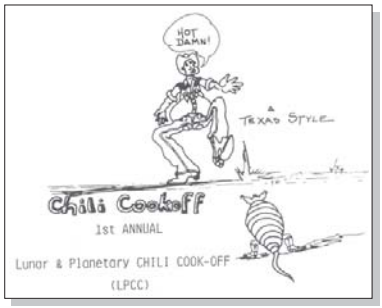
Former LPI Director, Thomas R. McGetchin, died on October 22 in a Honolulu hospital after a 6-month battle with cancer. He was 43 years old. Under McGetchin's direction the Institute expanded from the narrow focus of lunar science to the broader fields of planetary and terrestrial sciences. He was an exceptionally competent scientist and an outstanding leader.

PUBLIC RESPONDS TO VIKING FUND

— Issue 26, February 1981

Early this year in a quiet ceremony at the National Air and Space Museum, a check for $60,000 was delivered to space program officials, the first installment in what the organizers of the *Viking Fund* hope will be an annual contribution of at least $100,000. The purpose is to keep the robot landed on Mars in the Viking I mission in the planetary information business.

[*Editor's note: Wonder what happened to those funds? Contact with Viking I was lost in 1982 (Issue 35, May 1983). The next Mars lander was not until Pathfinder in 1997.*]



1ST ANNUAL CHILI COOK-OFF & BAR-BE-QUE
— Issue 26, February 1981

IN MEMORIAM: HAROLD CLAYTON UREY, 1893–1981
— Issue 26, February 1981

IT'S INCREDIBLE! IT'S BEAUTIFUL! IT'S SUPER!
— Issue 27, June 1981

Such expressions were the order of the day during the successful flight of Columbia, STS-1. The first space flight of the Shuttle orbiter was completed on April 14, 1981, when it landed on Rogers Dry Lake at Edwards Air Force Base, CA. Its condition upon return was deemed excellent by program officials of NASA.

[*Editor's note: In an ironic twist of fate, the same spacecraft associated with one of the brightest moments in shuttle history was also associated with one of its darkest moments, as the Columbia broke up in mid-air on February 1, 2003.*]

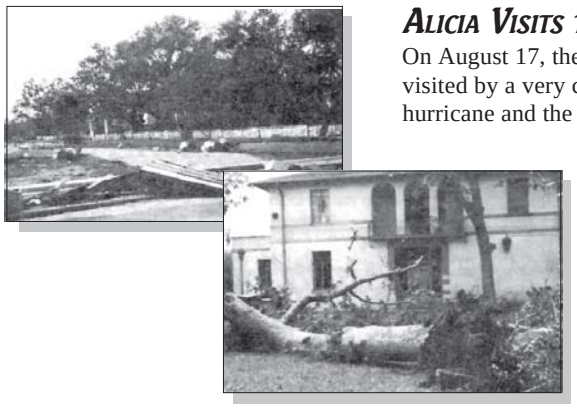
SPECIAL SESSION AT 14TH LPSC
— Issue 35, May 1983

Return to the Moon, Wednesday afternoon session during the XIVth LPSC.

[*Editor's note: Recognize any of these faces? If you think they looked frustrated then . . .*]

PIONEER 10 BEYOND THE KNOWN PLANETS
— Issue 35, May 1983

On June 13th of this year, the U.S. unmanned spacecraft, Pioneer 10, will cross the orbit of Neptune. With that crossing, Pioneer will be farther out from the Sun than any known planet, and will, in effect, have left the solar system. Though Pluto is normally the outermost planet, its orbit is so elliptical that for the next 17 years it will be inside Neptune's orbit, and Pluto will never again catch up with Pioneer.



ALICIA VISITS THE LPI
— Issue 36, November 1983

On August 17, the Texas Gulf Coast and the Lunar and Planetary Institute were visited by a very capricious lady named Alicia. For many of us this was our first experience with a hurricane and the memories will linger a long time. We lost approximately 25% of the trees at the Institute while most of the remainder had some damage. We were without electric power for nine days following the storm and without telephone service for almost two weeks.

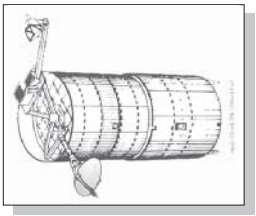
ORIGIN OF THE MOON CONFERENCE LEAVES ISSUE STILL DEBATABLE
— Issue 39, November 1984

Over 100 scientists met in Kona, Hawaii, October 13–16, 1984, to participate in the Conference on the Origin of the Moon. The conference opened with a number of invited papers, designed to review the various theories which have been proposed to explain the origin of the Moon. Discussions of the geophysical, dynamical, and petrological and geochemical constraints which influence the origin theories followed the invited reviews. Two sessions titled "My Model of Lunar Origin" allowed several researchers to present their theories in more detail to the assembly.

[*Editor's note: Despite the equivocal tone, this proved to be a seminal conference, leading directly to the consensus view that the Moon formed from a giant impact with Earth.*]

IN MEMORIAM
— Issue 43, February 1986

Planetary Observer Class Spacecraft — Illustration shows possible design variant based on existing satellite series.



MARS OBSERVER INVESTIGATIONS SELECTED
— Issue 44, May 1986

As a first step towards returning to Mars exploration, NASA announced selection of 33 possible investigations for the Mars Observer mission scheduled for launch in 1990. During the next 6 months (instrument accommodation phase), each proposed investigation will be evaluated for compatibility with the Mars Observer spacecraft and mission. The Mars Observer mission, first in a new series of planetary observer missions to the inner solar system, will carry seven or eight instruments.
[*Editor's note: Mars Observer disappeared on approach to Mars in 1993.*]

NASA SELECTS INVESTIGATIONS FOR COMET RENDEZVOUS MISSION — Issue 45, November 1986

NASA has selected 38 possible investigations for the Comet Rendezvous Asteroid Flyby (CRAF) mission planned for launch in the early 1990s. The mission is designed to send an unmanned U.S. spacecraft to rendezvous with a comet, fly in formation with it for 3 years, and fire an instrumented penetrator into the comet's nucleus. The spacecraft also will make close flybys of two asteroids on its way to the comet encounter.
[*Editor's note: And the comet mission saga continues . . .*]

HIGHLIGHTS OF THE 19TH LUNAR AND PLANETARY SCIENCE CONFERENCE — Issue 50, May 1988

Bevan French of NASA Headquarters presents a plaque commemorating the American discovery of the martian moon Phobos to Lev Mukhin of the Soviet Space Research Institute.

Two unique scientists take time out from the hectic schedule.
From left: Sean Solomon, MIT, and Gerald Wasserburg, Caltech.

LUNAR POLAR PROBE CONFERENCE SCHEDULED PRIOR TO LPSC — Issue 52, February 1989

The Houston Space Society is planning the Lunar Polar Probe Conference to be held in Houston on March 11 and 12, the two days immediately preceding the 20th LPSC. The conference is intended to formalize plans for the development, funding, and launch of a small satellite to explore the polar regions of the Moon. Guest speakers at the conference will be Dr. Wendell Mendell of the NASA Johnson Space Center.
[Editors' note: Haven't we heard this story before?]

LET'S GO VISIT PLYMOUTH — Issue 56, May 1990

If you are interested in visiting a lunar colony, be sure to watch your TV news this fall for the airing of ABC Television of the movie-for-TV *Plymouth*. Plymouth is, or rather was, a small Oregon community that becomes uninhabitable following an industrial accident. The townspeople are transported to the Moon to become the first lunarians operating on a Helium-3 plant. To assure authenticity, NASA experts in the area of lunar base design and exploration, as well as the country's foremost experts in space architecture, have lent their knowledge and expertise to the production. Dr. Wendell Mendell and Dr. Mark Cintala from the NASA/Johnson Space Center and Pat Rawlings, space artist, have contributed to the research for this film.
[*Editor's note: And we are certain these individuals are still proud of their involvement with this project . . .*]

IN MEMORIAM: HAROLD MASURSKY, 1923–1990 — Issue 57, December 1990

Harold Masursky, for over 20 years a world-renowned pioneer in space exploration, died on August 24. His contributions to planetary geology, to the design of spacecraft instruments, and to international scientific cooperation will be long remembered.

SPAN DISBANDS — TRANSITION TO OPEN SYSTEM INTERCONNECT — Issue 58, February 1991

After 10 years of service to the NASA science user community, the NASA Space Physics and Analysis Network (SPAN) ceased to exist organizationally and functionally. The NASA science-oriented DECnet networking for which SPAN was responsible has been turned over to a new support group. Also, plans have been made to significantly alter the physical architecture of the network sometime in 1991.
[*Editor's note: The transition to the Internet. Remember SPAN? DECnet? OMNInet? NSI?*]

BREAKING GROUND FOR THE FUTURE — Issue 59, May 1991

The Lunar and Planetary Institute has been a fixture in planetary science for more than two decades. As most readers of the Bulletin are aware, the Institute's lease on the current site for the Institute, the West Mansion and its associated grounds, expired in 1989. Rice University [which owned the property] has kindly provided an opportunity to the Institute to continue to lease the West Mansion until we are able to move to a new site.

Through the efforts and support of NASA, both Headquarters and the Johnson Space Center, a new site has been located.

[*Editor's note: The LPI moved into its new facility in January 1991. Driving past the old building still elicits fond memories for many of us. Sadly, the West Mansion was sold soon after the LPI moved, and remains empty to this day.*]

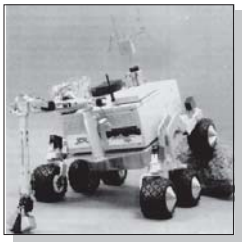
CHICXULUB: SITE OF THE K/T IMPACTOR? — Issue 60, August 1991

For more than a decade, scientists have been searching for the traces of a massive asteroid or comet impact on the Earth, believed to have caused extinction of the dinosaurs, among other species, at the geological boundary between the Cretaceous and Tertiary periods. Arguments over the precise rates of extinction continue, but it is clear that a tremendous decline in diversity in both continental and oceanic creatures occurred in what was, geologically speaking, an instant.

GALILEO ENCOUNTERS GASPRA; ANTENNA REMAINS STUCK — Issue 61, November 1991

Galileo passed within 1000 miles of the 11-mile-long asteroid, Gaspra, on October 29 [the first ever asteroid encounter] to record about 150 photos of the body. Data from the encounter will not be returned to Earth until the spacecraft makes its second Earth flyby in November 1992 because the troublesome high-gain antenna needed to transmit the images remains only partially deployed. Galileo's low-gain antenna can transmit the recorded data when it is nearer Earth.

[*Editor's note: The antenna finally became "unstuck" as the craft plunged into Jupiter's atmosphere in 2003.*]



MINIROVER TESTED ON MARSLIKE TERRAIN — Issue 61, November 1991

Scientists and engineers at NASA's Jet Propulsion Laboratory in Pasadena, California successfully tested a small robotic vehicle in rough terrain very similar to the two Viking landing sites on Mars. The test of the minirover, Rocky III, in the Avawatz Mountains south of Death Valley on September 11 demonstrated one of several low-cost approaches to future Mars exploration.

[*Editor's note: Does the rover look familiar? From Death Valley to Pathfinder to Endurance Crater . . . We've come a long way!*]

ASTEROID NAMED FOR LPI'S JONES — Issue 61, November 1991

Pam Jones, who heads the Program Services Department at LPI, has been honored by having an asteroid named for her. From the *Minor Planet Circular 18648*: (4852) Pamjones =1977 JD Discovered 1977 May 15 by N. S. Chernykh at the Crimean Astrophysical Observatory. Named in honor of Pamela Ann Jones, in appreciation of her organization of many conferences in planetary sciences.

[*Editor's note: During her 18 years at the LPI, Jones (now Solomon) organized more than 200 meetings in lunar and planetary science.*]

DOWNSIZED MISSIONS COULD BE MORE FREQUENT FLYERS — Issue 64, August 1992

In early May, NASA delivered a report to the U.S. Senate outlining a shift in emphasis toward smaller, lower cost, and more frequent planetary missions. The Small Planetary Mission Plan, which was requested by the Senate Committee on Appropriations, Subcommittee on VA, HUD and Independent Agencies chaired by Sen. Barbara Mikulski (D-Md.), describes two proposed missions that NASA has selected for preliminary studies leading to launches in 1996 and 1998.

[*Editor's note: And so the Discovery Program was born . . .*]

APOLLO 17 — TWENTY YEARS LATER — Issue 65, November 1992

Held to nearly coincide with the 20th Anniversary of the launch of the Apollo 17 mission, the Workshop on the Geology of the Apollo 17 Landing Site was a mixture of nostalgia and review on the one hand, and reports of recent, ongoing, and suggested future work on the other . . .

[*Editor's note: This article, written by Dr. Graham Ryder, ended with the author's hope that perhaps within 20 years, practical experience with some of the resource production techniques would have been obtained on the Moon itself. Sadly, Dr. Ryder died in 2002 never seeing his dream of a return to the Moon realized.*]

TO THE MOON AND GEOGRAPHOS: THE SDIO-NASA CLEMENTINE MISSION — Issue 66, February 1993

Clementine is a mission designed to test the space-worthiness of a variety of advanced sensors for use on military surveillance satellites. Conducted jointly by the Strategic Defense Initiative Organization and NASA, Clementine will be sent for an extended stay in the vicinity of Earth's Moon and on a flyby of the Apollo asteroid, 1620 Geographos. Thus, we are about to receive an unexpected bounty of planetary data through a serendipitous alignment of disparate technical objectives of both SDIO and NASA.

NEAR EARTH ASTEROID RENDEZVOUS WILL BE FIRST DISCOVERY MISSION — Issue 70, August 1994

NASA has begun full-scale development of the first spacecraft to rendezvous with and orbit an asteroid. The Near Earth Asteroid Rendezvous (NEAR) mission received funding in NASA's 1994 budget and will be the first launch in the Discovery Program of small-scale, cost-effective space exploration missions.

[*Editor's note: With its landing on asteroid 433 Eros on February 12, 2001, NEAR Shoemaker became the first spacecraft to orbit, land on, and send data from the surface of an asteroid.*]

THE HORRENDOUS SPACE KABLOOEY AT JUPITER (THE FATE OF COMET SHOEMAKER-LEVY 9) — Issue 72, August 1994

4 PM CDT, July 16, 1994: A single paragraph transmitted over the Internet is read by scientists across the world. We reread the message several times. Short on detail, the first reported observation, from Calar Alto, Spain, of the collision of the first fragment, A, of the comet P/Shoemaker-Levy 9 into Jupiter is nonetheless electrifying. Observers report that a "plume" is visible at 2.3 microns wavelength, brighter than Jupiter's moon Io. It is the first indication, after over a year of speculation and teeth gnashing, that we are going to be treated to some major fireworks.

GALILEO ARRIVES: PROBE MISSION SUCCESSFUL — Issue 78, Winter 1996

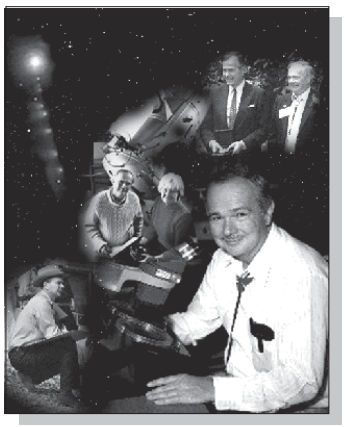
After a six-year odyssey the Galileo Probe plunged into Jupiter's atmosphere at 2:04 p.m. PST on December 7. During the first two minutes of entry, the craft experienced temperatures twice as hot as the Sun's surface and deceleration forces as great as 230 g's as it was slowed by the atmosphere. The Galileo Orbiter, which entered orbit around Jupiter a few hours after the Probe's descent, recorded 57.6 minutes of data from instruments before the Probe fell silent.

FOSSIL LIFE IN ALH 84001? — Issue 80, Summer 1996

This article is an explanation in layman's language of the *Science* (August 16, 1996) paper of Dr. David McKay and his co-workers, in which they give evidence that martian bacteria may have lived in the martian meteorite ALH 84001. Since the startling announcement, we [author Allan Treiman and colleagues] at LPI have fielded dozens of questions from the public and press about the research presented in the paper. [The author] tried to organize and review the evidence that ALH 84001 contains fossils and traces of ancient martian life, and also tried to outline some counter-evidence and some likely questions about the evidence . . .

REMEMBERING GENE SHOEMAKER, 1928–1997 — Issue 83, Fall 1997

The planetary science community lost one of its founding members when Dr. Eugene Shoemaker died in an automobile accident July 18 in Alice Springs, Australia. He was conducting field studies of impact craters with his wife and collaborator, Carolyn, who survived the accident despite serious injuries.



Bob Clayton, Gene Shoemaker, and George Wetherill cut the 25th [LPSC] anniversary cake, with David Black and Doug Blanchard looking on. *(Photo printed in Issue 86, Spring 1999)*

INVASION OF THE FLYING DISKS — Issue 86, Spring 1999

The Lunar and Planetary Science Conference has been touched by the swing toward electronic publishing. The conference has gradually phased out its "Yellow Peril" three-volume abstracts sets published each year in conjunction with the conference in favor of a single CD-ROM.

MICHIGAN STATE ESTABLISHES GRAHAM RYDER MEMORIAL FUND — Issue 92, Spring 2002

The Department of Geological Sciences at Michigan State University has established a memorial fund in the name of late LPI Staff Scientist Graham Ryder. Dr. Ryder passed away on January 5 [2002] as a result of complications from cancer of the esophagus. He was 52.

20TH ANNUAL INTERN CONFERENCE

The LPI Summer Intern Program in Planetary Science has been part of the Lunar and Planetary Institute (LPI) mission for 28 years. The program allows undergraduates to experience cutting-edge research in the planetary sciences by working one on one over a 10-week period with a scientist at the LPI or the NASA Johnson Space Center. This year marked the twentieth year that interns were able to present their projects as part of an intern conference. The conference was chaired by Dr. Julie Moses, staff scientist at the LPI. What follows are brief abstracts of the interns' research projects and presentations. Information about the summer intern programs can be found at the end of this article.

3.54 Billion-Year-Old Cherts from Western Australia: Were They Formed by Living Organisms?

Emily Bjonnes, *Rutgers University — Advisor:* John Lindsay, *LPI*

Ancient carbon-rich cherts, 3.54 billion years old, from the Coucal formation of Western Australia provide a unique opportunity to look into processes working in the Archean environment. These sedimentary units have been interpreted as hydrothermal in origin (not biogenic), although field relations are ambiguous. The fundamental question here is whether the carbon in the black cherts contains evidence of ancient life or whether it results from inorganic processes (either primary deposition or replacement of other rock types). Thin sections of the cherts were studied under the petrographic microscope, and suitable sections were analyzed on the electron microprobe and scanning electron microscope. The first question to be addressed was whether the cherts were primary hydrothermal deposits or the replacement of another rock type. Hand-specimen analysis, optical and scanning electron microscopy, whole-rock geochemistry analyses, and an examination of the surrounding geology of the unit suggest that the Coucal formation formed in a hydrothermal environment. No evidence of biological origin of the cherts was found, and the carbon in them is therefore inferred to be abiotic in origin.

Automated Classification of Martian Topographical Data

Brian Bue, *Augsburg College — Advisor:* Tomasz Stepinski, *LPI*

The morphology of martian terrain is of great interest because it helps to identify physical processes responsible for the observed topography. Traditionally, the descriptive method, applied to imagery data, has been used to study and categorize martian terrain. This project used a complementary approach, wherein a thematic map of topographical features was automatically constructed by a clustering computer algorithm. Using martian digital topography obtained from the Mars Orbiter Laser Altimeter (MOLA) data, digital elevation models (DEMs) of a number of martian locations were constructed as input for the clustering algorithm. These DEMs were modified so that, in addition to elevation, each pixel carried additional topographical information. The output was a thematic map, wherein each pixel was assigned a label associated with a particular topographical feature. Several thematic maps of martian topography were generated and compared to images and geological maps of the same regions in order to assess an effectiveness of automated classification method. The process was successful for several individual regions, but certain changes in the way craters are identified, characterized, and counted, as well as other possible improvements to the algorithm, have been suggested.

Minerology and Petrology of Lunar Mare Basalts LAP 02205, LAP 02226, LAP 02224, and LAP 02436

Sarah Collins, *Imperial College of Science, Technology and Medicine — Advisors:* Kevin Righter and Alan Brandon, *NASA JSC*

LAP 02205 is a lunar mare basalt meteorite found in the Lap Paz ice field of Antarctica in 2002. Three similar meteorites (LAP 02224, LAP 02226, LAP 02436) were also found in the same region. These LAP meteorites all contain a similar mineral composition, texture, and mineral assemblage. The LAP meteorites likely represent an area of the Moon that has never been sampled by Apollo missions or other lunar meteorites. It is therefore crucial that these meteorites are studied and their origin understood. The meteorites were examined optically using a petrographic microscope and were analyzed using an electron microprobe, and the results were compared with Apollo samples. The textures and mineralogy of these four LAP meteorites are similar enough to conclude that they originated from the same lava flow or group of flows on the Moon. They contain high Al_2O_3 but are depleted in MgO compared to other lunar samples. Other characteristics of the parent lava flow and meteorites, such as the flow thickness and cooling rate, the oxidation state of the basalts at the time of crystallization, and the liquidus temperature of the meteorites were determined. The presence of cristobalite within the meteorites is not consistent with the inferred liquidus temperatures, and it is inferred that the cristobalite occurs metastably within these samples.

Evidence for Extensive Fluvial Erosion Around Olympus Mons: A Multiresolution Study

Selby Cull, *Hampshire College — Advisors:* Patrick J. McGovern and Allan Treiman, *LPI*

Olympus Mons is an immense volcano (23 km height above base, ~600 km wide) located to the northwest of the Tharsis Rise on Mars. Lobate deposits with rugged block and ridge morphology (the vast Olympus Mons aureole deposits) extend outward from the steep basal scarp surrounding the volcano for hundreds of kilometers. The aureole lobes may result from large flank failure events facilitated by pore fluids in a basal layer beneath the volcano. We use topography and pulse-width data from the Mars Orbiter Laser Altimeter (MOLA) instrument aboard the Mars Global Surveyor (MGS) spacecraft, along with daytime infrared images from the Thermal Emission Imaging System (THEMIS) and visual THEMIS (THEMIS-VIS) images from the Mars Odyssey mission, to survey the aureole lobes and regions surrounding Olympus Mons to search for fluvial activity related to pore fluid transport during aureole emplacement. We found abundant evidence for fluvial features such as channels and streamlined "islands" in the plains and aureole materials surrounding Olympus Mons. We also identified two potential paleolakes (regions of anomalous topographic smoothness) near the base of the edifice and a spillway that channeled fast and short-lived hydrous flows from the Tharsis rise and eastern/northeastern Olympus Mons aureole deposits toward the Amazonis lowlands of Mars. Our results are consistent with the hypothesis that there is a groundwater system beneath Olympus Mons, that this system is extensive, and that its interaction with tectonism has produced much of the fluvial activity observed around the volcano.

EXPERIMENTAL PETROLOGY OF THE NEW MARTIAN METEORITE YAMATO 980459

Heather Dalton, *Stephen F. Austin State University — Advisors:* Donald Musselwhite and Allan Treiman, *LPI*

A new martian meteorite Y980459 has recently been announced (Misawa, 2003). This new meteorite is an olivine-phyric basaltic shergottite. Based on its highly magnesian character (McKay and Mikouchi, 2003) it appears to be the most primitive martian basalt known to date. As such it can provide insight into the character of the mantle source region for the martian basalts. Crystallization experiments utilizing synthetic glass starting materials with the Y980459 bulk composition were conducted. The goal of these experiments was to determine the solid phases that are stable at the liquidus and to map out the pressure-temperature trajectory of the liquidus for this composition. The proximity of the experimental points to a correlation line from Jones (1995) shows that there is equilibrium partitioning between Mg and Fe in the samples. The results from the experimentally determined liquidus were compared with the calculated results from MELTS program for a similar composition. The experimental liquidus was found to lie well below the calculated liquidus from the MELTS software. In addition, MELTS determined the liquidus to have a linear relationship between temperature and pressure, whereas the experiments show that the liquidus line begins to curve downward slightly as pressure increases. The implications of the observed experimental behavior are discussed.

FIELD EXPERIENCE FOR MARS EXPLORATION VIA INFRARED SPECTROMETERS

Nicolas Heavens, *University of Chicago — Advisor:* Laurel Kirkland, *LPI*

This project explored terrestrial analogs in order to develop and test capabilities to identify minerals on Mars. NASA currently has three thermal infrared spectrometers operating at Mars. One spectrometer (called "TES") is on the Mars Global Surveyor Orbiter. Each of the two Mars rovers carries a similar spectrometer (called "Mini-TES"). A primary mission goal is to use the spectrometers to identify the minerals present on Mars, because minerals can provide information for geologic and climatic interpretations. For example, the sulfate mineral jarosite has been proposed to be present on Meridiani Planum based on Mössbauer spectroscopy. This mineral forms in the presence of liquid water on Earth; due to the assumed connection between liquid water and life, it would be important from an astrobiology standpoint to attempt to confirm the identification of jarosite using infrared spectroscopy. In this project, we test the identifiability of jarosite and other rocks and minerals using Mini-TES-like field measurements of sulfate-rich mining areas in Arizona and Nevada. We find that jarosite and specific types of igneous and sedimentary rocks are identifiable in our Mini-TES analog field measurements. However, the identifiability of minerals is not only controlled by their abundance but can depend significantly on the physical properties of other minerals that are also present at the site. Abundance mapping based on band depth failed miserably at one of our sites. We also find that effluorescent salts do not appear to have identifiable spectral features in our Mars-analog sites, but they may reduce the spectral contrast of minerals mixed with them.

TOPOGRAPHIC STUDY OF LARGE MARTIAN IMPACT CRATERS

Jared Howenstine, *University of Massachusetts Amherst — Advisor:* Walter Kiefer, *LPI*

This project quantified the morphology of large impact structures on Mars using gridded topography models from Mars Global Surveyor. We examined 39 visible impact craters with diameters between 66 and 518 km, 22 quasi-circular depressions (QCDs) with diameters between 200 and 650 km, and the large impact basins Argyre, Isidis, and Hellas. Previous studies of martian crater morphometry were limited to diameters of up to 100 km, so our results overlap with existing work and extend these results to some of the largest impact structures on Mars. For each structure, we measured the basin diameter, the rim-to-floor depth, and the external rim height on at least four topographic profiles across the structure in order assess the statistical variability of our measurements. Comparison of these results on depth versus diameter and rim height versus diameter plots allowed us to identify which craters are the most pristine and the least subject to subsequent filling. Most large impact craters on Mars now have up to several kilometers of post-impact fill within the impact structure. Our results quantify the magnitude of this fill and will be used as constraints on subsequent gravity models of these features.

SEARCH FOR FLUID INCLUSIONS IN METEORITES AND INITIAL CHARACTERIZATION

Yoko Kebukawa, *Tokyo Institute of Technology — Advisor:* Michael Zolensky, *NASA JSC*

Following the 1999 discovery of the first aqueous (water-bearing) fluid inclusions in halite in an ordinary chondrite meteorite, efforts are underway to locate fluid inclusions in other meteorites, particularly fluid inclusions in carbonate minerals in carbonaceous chondrites. A critical problem has been the inability to verify that the features that are seen are truly aqueous fluid inclusions rather than other features or contamination. This problem can be addressed with the new Raman microprobe that is now available at the NASA Johnson Space Center. With this new instrument, it is possible to non-destructively detect water or aqueous fluid inclusions in meteorite minerals. The project was designed to search for fluid inclusions among the numerous chondrite samples that have been assembled over the past five years, and analyzing these features by Raman spectrometry to determine which are truly indigenous aqueous fluid inclusions. Features that could be fluid inclusions were found in transparent grains of Ca-Mg-Fe carbonate in the Ivuna (C12) and Tagish Lake meteorites. However, none of the inclusions found in these meteorites contain liquid with a moving vapor bubble. On the other hand, numerous fluid inclusions and a moving vapor bubble were found in halite from the Zag (H3-6) chondrite meteorite; however, water signatures from these inclusions were not confirmed by laser Raman microprobe, probably because the inclusions are so small.

PROSPECTING FOR ANCIENT MARTIAN ICE

Scott McBride, *Cornell University — Advisors:* Carlton Allen, *NASA JSC*, Mary Sue Bell, *Lockheed Martin*

Recent data from the Mars Odyssey Gamma Ray Spectrometer suggest the presence of abundant near-surface ice in the martian polar regions. This ice is apparently in thermal equilibrium with the present martian climate. High-resolution orbital imagery from the Mars Global Surveyor and Viking spacecraft show geomorphic evidence of deeper ice at mid-latitudes, apparently dating to periods of higher planetary obliquity. This ancient ice reservoir may hold a significant percentage of Mars' remaining water inventory. Ejecta blanket morphologies are strongly affected by

the presence of ice in the target materials. Ejecta blankets change with crater diameter, and these changes have been interpreted as indicators of the depth of subsurface volatiles. The age of the ice deposits may be addressed by analysis of the ejecta blanket morphologies of older versus younger craters. Mars Global Surveyor and Viking orbital images, as well as the Mars Crater Catalog, were used to map morphologic differences among craters in the martian northern plains. Crater morphologies and ages were correlated with previously mapped areas of subsurface ice. The relationship of crater diameter to morphology was used to estimate the thickness and age of these ice deposits. We conclude that an ice-rich layer approximately 40 m thick is revealed by the presence of recently active ice-wedge polygons in the Casius quadrangle region, and possibly more extensively across the northern plains. Higher obliquity probably caused the deposition of the ice-rich mantle before 5 Ma; formation of the polygons has continued until the present.

IRON METAL SPHERULES FOUND AT DEEP-SEA HYDROTHERMAL VENT

Táhirih Motazedian, *University of Oregon — Advisor:* Kelly Snook, *NASA JSC*

The primary purpose of this project was to analyze and characterize biological and geological samples from the mid-oceanic deep-sea hydrothermal vents collected during the 2003 NASA Oceanographic Analog Missions Activity (NOAMA) project. Discovered relatively recently in 1977, the hydrothermal vents and their associated ecosystems along the ridges where the tectonic plates meet are thought to hold the key to the origin of life on Earth. On the NOAMA expedition, approximately 20 scientists and filmmakers journeyed to the vents in small manned submersibles launched off a large Russian research vessel; approximately 150 kg of rock, sediment, vent water, biological, and microbiological samples were collected from six sites along the mid-Atlantic ridge and the East Pacific Rise from depths of 840 m to 3625 m. Using optical microscopy, SEM, microprobe, XRD, and Raman spectroscopy, we have analyzed an interesting basaltic rock that was retrieved from the Menez Gwen hydrothermal vent field during the NOAMA expedition. This pillow basalt contained over 1000 small metallic spherules embedded in the rock. Analysis shows that the spherules are made of iron metal and have hematite weathering rinds that have formed since the samples were collected. With the aid of international colleagues we have ascertained that these metal spherules are actually shot ballast dropped by the Nautile submersible, which has visited Menez Gwen from its discovery. We speculate that these iron shot pellets must have sunk into a pillow of fresh basaltic lava exuded from the Menez Gwen volcano and cooled inside of the rock as it hardened.

AN INFRARED SPECTROSCOPY AND ELECTRON MICROSCOPY STUDY OF ANTARCTIC MICROMETEORITES: MINERALOGY AND ORGANIC MATTER

Akiko Suzuki, *Kyushu University — Advisor:* Lindsay Keller, *NASA JSC*

Interplanetary dust particles (IDPs) collected in Earth's stratosphere contain significant quantities of organic matter. IDPs and micrometeorites may have been important sources of pre-biotic organic matter on the early Earth, yet little is known about the quantity and nature of organic matter in these particles. We have undertaken a study of small micrometeorites (50–100 µm) in order to determine the types and abundances of organic matter present in them. We also wanted to compare our results to earlier work on large IDPs and micrometeorites. Despite being heated strongly during atmospheric entry, we observed indigenous organic matter in all but one of the twelve micrometeorite samples we analyzed. The detectable organics were aliphatic hydrocarbons, and their abundance is intermediate between those of IDPs and of the matrices in carbonaceous chondrite meteorites. The pyroxene-rich and clay-rich particles showed the highest abundance of aliphatic hydrocarbons.

Students participating in the 2004 LPI Summer Intern Program.
From left to right, front row: Brian Bue;
middle row: Akiko Suzuki, Emily Bjonnes, Jared Howenstine, and Heather Dalton;
back row: Táhirih Motazedian, Scott McBride, Nicholas Heavens, Sarah Collins, Selby Cull, and Yoko Kebukawa.

PLANETARY INTERN PROGRAMS AVAILABLE

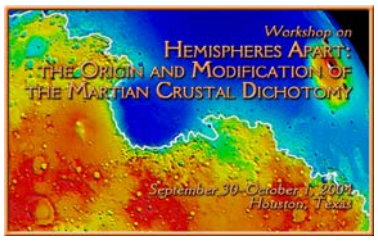
At least three other student programs in the planetary sciences are currently available. For more information about these programs, visit these Web sites.

Planetary Geology and Geophysics Undergraduate Research Program
http://www.acsu.buffalo.edu/~tgregg/pggurp.html

California Institute of Technology Summer Undergraduate Research Fellowships (SURF) Program
http://www.cco.caltech.edu/%7Esurf/

LPI Summer Intern Program
http://www.lpi.usra.edu/lpiintern.html

Meeting Highlights



Workshop on Hemispheres Apart: The Origin and Modification of the Martian Crustal Dichotomy

The origin of the martian hemispheric dichotomy is one of the most enduring questions about the planet's evolution. The dichotomy is a fundamental feature of Mars that is manifested in its topography, geology, tectonics, cratering record, magnetic field, and crustal structure. The nature and origin of the dichotomy and the dichotomy boundary remain uncertain. While impact(s), mantle convection, and plate tectonics have all been proposed for the formation of the dichotomy, no consensus on its origin has been reached. However, data from recent and ongoing missions, including Mars Global Surveyor and Mars Odyssey, offer the potential for new insights into the processes that formed and modified the dichotomy. To assess recent progress and outline new avenues of approach, this workshop was held September 30–October 1, 2004, at the Lunar and Planetary Institute in Houston, and was attended by 37 scientists from a broad range of disciplines.

Perhaps the most significant results of the workshop were related to issues of timing. The broad consensus was that the hemispheric dichotomy is a primordial feature of the crust of Mars. For example, topographic data reveal populations of previously hidden, buried impact basins in the northern lowlands and southern highlands, indicating ancient ages for basement materials and a comparably ancient origin of the dichotomy. Analysis of isotopic systems in SNC meteorites suggests that martian crustal formation was essentially complete by perhaps as soon as 50 million years after solar system formation. Such an early age for the dichotomy is problematic for many endogenic (internally driven) scenarios for dichotomy formation, including plate tectonics and mantle convective tractions, which require timescales on the order of hundreds of millions of years to move the crust into the required configuration. However, overturn of a primordial magma ocean may allow the crustal dichotomy to form within the required timeframe. Removal of northern lowlands crust by giant impacts, the leading exogenic (externally driven) dichotomy formation scenario, does not suffer from the timing issue, but geologic, topographic, or gravity evidence for degraded ancient impact basins in the lowlands is lacking. However, our understanding of the effects of giant impacts on crustal structure is in an embryonic stage, in part due to the paucity of models for such events. The workshop participants called upon the impact modeling community to address the situation, so that the likelihood of impact-based scenarios for martian crustal dichotomy formation can be rigorously evaluated.

Second Conference on Early Mars: Geologic, Hydrologic, and Climatic Evolution and the Implications for Life

Since the first conference was held in April 1997, scientists have benefited from a wealth of new data from the six successful spacecraft missions that have been flown to Mars by NASA and the European Space Agency. This data has led to significant progress in understanding the nature and evolution of the early climate and the planet's ancient cratered highlands, especially with regard to the growing evidence that early Mars was water-rich. When considered in the context of the recent discoveries about the origin and diversity of life on Earth, these new insights have reinvigorated interest in both the conditions that prevailed during the first billion years of martian geologic history and their implications for the development of indigenous life.

To address this interest and assess our current understanding of these issues, the Second Conference on Early Mars was held in Jackson Hole, Wyoming, on October 11–15, 2004. One hundred and thirty-seven terrestrial and planetary scientists, representing a wide range of fields in the physical and biological sciences, participated. The conference location was selected because of its proximity to the many hydrothermal sites in Yellowstone National Park. Hydrothermal environments are believed to have been critical to the development of life on Earth and are also thought to have been widespread on early Mars. The Yellowstone geysers and hot springs were the focus of a highly successful mid-conference field trip.

The meeting included discussions of the evolution of the early Sun, the volatile inventories of the terrestrial planets, and how impacts, volcanism, and the presence of abundant water affected the physical and chemical environment that existed on Mars 4 G.y. ago, particularly as it related to the nature of the global climate, the existence of a primordial ocean, the origin of the valley networks, the geologic and mineralogic evolution of the surface, the potential presence of habitable environments, and the preservation of life's signature in the geologic record. These discussions were based on presentations of the latest data derived from analyses of the SNC meteorites and from recent spacecraft missions (including detailed reports of the new discoveries made by the MER Rovers and Mars Express), as well as from recent work on the origin of life and life in extreme environments on Earth. One of the most significant new findings reported at the meeting was that it appears Mars underwent many of its most important changes much earlier in its history than previously thought, including core formation, the development of the crustal dichotomy, a rapid decline in geothermal heat flow, and the loss of a planetary magnetic field. Surprisingly, all these events appear to have occurred within the planet's first 50–100 million years of existence.

A related discovery is the potential role played by large impacts during this same period, a topographic record of which is preserved in the ancient cratered highlands and has now also been detected beneath the planet's northern plains. Simulations indicate that the very largest of these impacts (with basin diameters >103 km) may have blown away a significant fraction of the early martian atmosphere, while the impacts that produced craters >100 km in diameter may have affected the climate on a regional and global scale, creating transient environmental conditions capable of sustaining continuous rainfall lasting from years to decades.

There now appears to be overwhelming evidence that early Mars was water-rich and may have possessed standing bodies of water and ice that ranged from large seas to a primordial ocean, covering as much as a third of the planet. Supporting evidence ranges from orbital observations of extensive layered terrains within, and possible paleoshorelines surrounding, the northen plains to *in situ* investigations of the mineralogy and sedimentary record recently discovered by the Opportunity rover in Meridiani Planum. The implications of these findings are just beginning to be absorbed by the Mars community, yet they have already substantially revised our understanding of the planet's early evolution. They are certain to be a continued focus of attention as the intensity and scope of Mars exploration increases over the next decade.

Spotlight on Education

"Spotlight on Education" highlights events and programs that provide opportunities for space scientists to become involved in education and public outreach and to engage science educators and the community. If you know of space science educational programs or events that should be included, please contact the Lunar and Planetary Institute at outreach@lpi.usra.edu.

Sun-Earth Day: Ancient Observatories, Timeless Knowledge

This year *Sun Earth Day* will feature ancient and modern observatories from around the world. Students, educators, and the general public can learn more of the integral relationship of the Sun to ancient cultures — and to our own. Events include

Winter Solstice, December 21, Webcast from Chaco Canyon
Sun Earth Day, March 18
Spring Equinox, March 20, Webcasts from Chichén Itzá

Teacher guides, activities for student involvement, and a wealth of information are available for educators on the Web site (*http://sunearthday.nasa.gov*). Packages and avenues for involvement are available for museums, science centers, libraries, and other learning environments. Amateur astronomers are encouraged to participate.

Sun Earth Day will help participants learn more about ancient observatories and develop the understanding that

- Our Sun is a dynamic, magnetic star that impacts Earth and other planets in our solar system
- Understanding the mysteries of our Sun has been a primary motivator for Sun watchers through time
- We use technology to understand the Sun and the universe beyond; this technology has changed through time
- Light has always provided a means of investigating the universe
- Human beings from diverse cultures have viewed the Sun as the source of life
- Stewardship of these ancient observatories is our collective responsibility

Celebrating the Einstein Centennial: 1905–2005

In June of 1905, Albert Einstein published four amazing physics papers, including his theory of special relativity (suggesting that light travels at a constant speed, while time can slow down or speed up) and his famous relationship between matter and energy: $E = mc^2$. Einstein's new ideas about the connections between space, time, matter, and energy revolutionized our view of the universe we live in. Now, 100 years later, there is a unique opportunity to celebrate the ongoing quest to understand our place in space and time. The Structure and Evolution of the Universe Forum shares events, resources, and programs designed to increase public awareness and understanding about the nature of space and time, and our ever-evolving place in the cosmos. To learn more, visit their Web site at *http://cfa-www.harvard.edu/seuforum/einstein/*.

American Geophysical Union Fall Meeting, December 13–17

Almost 40 sessions at the 2004 AGU Fall Meeting in San Francisco will explore Earth and space science education. Planned sessions include

- Using planetary data in educational settings
- Comparing Earth and our planetary neighbors
- Teaching with visualizations
- Space observations for Earth systems science education opportunities in the IPY and IHY
- Promoting authentic scientific research in the classroom
- Making an impact in education and outreach with little or no resources
- Research experiences for undergraduates in the Earth and space sciences
- Undergraduate Earth system science education
- Partnerships and networks: Keys to sustainability and systemic reform in K–12 Earth and space science education
- Teacher professional development programs
- Growth and development of EPO as a profession

Several sessions will explore diversity and equity issues in the Earth and space sciences, including sessions on lessons learned, successful models, and building partnerships. A complete list of the sessions and schedule, as well as links to abstracts, can be found at *http://www.agu.org/cgi-bin/sessionsfm04?meeting=fm04&sec=ED*.

FLOODS AND FLOWS: EXPLORING MARS GEOLOGY ON EARTH — A FIELD EXPERIENCE FOR EDUCATORS

Twenty-four K–12 educators and educational specialists from ten states spent seven days exploring the flood deposits and erosional features of ancient Glacial Lake Missoula (Montana) and the lava flows and features of Craters of the Moon (Idaho) during the "Floods and Flows: Exploring Mars Geology on Earth" field trip and workshop. The field experience, led by researchers from the Lunar and Planetary Institute, was funded by a NASA Office of Space Science E/PO supplement to a research grant. Approximately three-quarters of the participants received financial assistance from the Lunar and Planetary Institute and Sandia National Laboratories.

Presentations, discussions, and activities were based at the University of Montana, Missoula. Hands-on, inquiry- and standards-based activities were used to connect the field experiences to the geology of Mars. The educators created Web pages for each field trip stop (*http://www.lpi.usra.edu/education/fieldtrips/2004/*). The Web pages are a way to communicate information, but also to assess understanding and application by the participants. The 2005 field experience, "Life at the Limits," will focus on building knowledge of life in Earth's extreme environments in the northern California area. Participants will use their understanding to draw conclusions about astrobiology and the possibility of life on other planets. For more information about these field experiences, as well as supporting classroom resources, explore the Web site at *http://www.lpi.usra.edu/education/other_programs/ed_fieldtrips.shtml*. Information about the 2005 field trip will be posted in January 2005.

FUNDS FOR SPACE SCIENTIST/EDUCATOR COLLABORATIONS

The South Central Organization of Researchers and Educators (SCORE), a Broker/Facilitator in NASA's Directorate for Science Support Network, offers two grant programs for educator/researcher partnerships:

Educator Researcher Collaborative Projects. Grants of up to $1000 are available to collaborative teams of educators and OSS researchers in the SCORE six-state region. The grants are intended to help initiate new partnerships. Funds can be used to purchase materials and resources to increase student or public understanding of space science content. The application deadline is **December 15, 2004.** More information is available at *http://www.lpi.usra.edu/education/score/collaborativeprojects.shtml*.

Educator Researcher Workshops. Grants to assist in the development and implementation of local professional development workshops for educators are available to teams of educators and OSS researchers in the SCORE six-state region. Workshop design is flexible and should meet the needs of the local community. Funding deadline for spring workshops is **January 15, 2005.** More information is available at *http://www.lpi.usra.edu/education/score/collaborativeworkshops.shtml*.

The ***Toyota TAPESTRY Grant Program*** awards 50 grants of up to $10,000 each and a minimum of 20 "mini-grants" of $2,500 each to K–12 science teachers. Interested teachers should propose innovative science projects that can be implemented in their school or school district over a one-year period. Toyota TAPESTRY projects demonstrate creativity, involve risk-taking, possess a visionary quality, and model a novel way of presenting science. The deadline is **January 19, 2005**. For more information, visit *http://www.nsta.org/programs/tapestry/index.htm*.

OTHER RESOURCES

Evolution of Our Solar System Timeline

Explore the changes in our solar system and on Earth over the last 4.5 billion years at *http://www.lpi.usra.edu/education/timeline/*. The Web site, intended for the general public, includes an interactive timeline, a gallery of images and captions, and information about ordering the timeline from participating printers.

Interested in becoming more involved in space science education and public outreach? NASA's OSS Support Network encompasses a nationwide network of Broker/Facilitators and Education Forums that are prepared to assist space science investigators in developing high-quality, high-impact E/PO programs. For more information about the network, or to contact the Broker/Facilitator in your region, please visit *http://spacescience.nasa.gov/education/index.htm*.

News From Space

Genesis Researchers Report Progress

As scientists unpack and examine more than 3000 containers of samples of the Sun brought to Earth on September 8 by NASA's Genesis mission, the Mishap Investigation Board has identified a likely direct cause of the failure of Genesis' parachute system to open: a design error involving the orientation of gravity-switch devices. "I can tell you we have come a long way from September 8, and things are looking very, very good," said Eileen Stansbery, Johnson Space Center assistant director of astromaterials research and exploration science. "Retrieving the concentrator target was our number one priority. When I first saw three of the four target segments were intact, and the fourth was mostly intact, my heart leapt." Other milestones included the discovery that the gold foil collector was undamaged and in excellent condition. The gold foil, which is expected to contain almost a million billion atoms of solar wind, was considered the number two priority for science recovery. "But here we are, with an opportunity to fulfill our major science objectives. It is a great day for Genesis, and I expect many more to come," said Project Manager Don Sweetnam of NASA's Jet Propulsion Laboratory.

Mars Rovers Probing Water History at Two Sites

NASA's Spirit and Opportunity rovers have been exploring Mars about three times as long as originally scheduled. The more they look, the more evidence of past liquid water on Mars these robots discover. Spirit is climbing higher into the "Columbia Hills," driving more than three kilometers (approximately two miles) across a plain to reach them. "We haven't seen a single unaltered volcanic rock, since we crossed the boundary from the plains into the hills, and I'm beginning to suspect we never will," said Dr. Steve Squyres of Cornell University. "All the rocks in the hills have been altered significantly by water. We're having a wonderful time trying to work out exactly what happened here." "Our leading hypothesis is that these rocks originated as volcanic ash that fell from the air or moved in ground-hugging ash flows, and that minerals in them were altered by water," said Dr. Ray Arvidson of Washington University, St. Louis. As for the future of the rovers, Jim Erickson, project manager at JPL, said "Both Spirit and Opportunity have only minor problems, and there is really no way of knowing how much longer they will keep operating . . . While they're healthy, we'll keep them working as hard as possible."

Cassini Encounters Titan

Early analysis of images and other data captured during Cassini's first close flyby of Saturn's moon Titan on October 26 revealed greater surface detail than ever before, showing that Titan has lost much of its original atmosphere over time. Cassini swooped down to within 1174 kilometers (730 miles) of Titan during the close encounter and used its imaging radar for the first time to peer through the thick haze surrounding Titan. A strikingly bright feature that is consistent with an active geology was seen. One of the possibilities is that this feature is a "cryovolcanic"flow or "ice volcano." "It may be something that flowed," said Cassini radar team member Dr. Ralph Lorenz of the University of Arizona. "Or it could be something carved by erosion. It's too early to say." Dr. Jonathan Lunine, also of the University of Arizona, said "Titan is a dynamic place with complex geologic processes that may be shaping its surface. Its surface may well be covered with organic materials, but we still don't know how much of the surface is liquid or solid. The fact that we have seen few craters tells us that Titan's surface is young." The Huygens probe, built and managed by the European Space Agency, will be released on December 24 for a descent into Titan's atmosphere on January 14, 2005.

SMART-1 Enters Moon's Orbit

Launched by an Ariane 5 booster in late September 2003, the European Space Agency's Small Missions for Advanced Research in Technology, or SMART-1, has been captured by the Moon's gravity. Now in a wide orbit around the Moon, the spacecraft will begin adjusting its orbit over the next several weeks. SMART-1 is slated to begin its scientific study of the lunar surface in January of next year. Among its tasks will be the search for signs of water in the form of ice on the Moon. That ice is thought to be tucked away within permanently shadowed craters at the lunar poles, which are free from the warming rays of the Sun.

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The *Bulletin* welcomes articles dealing with issues related to planetary science and exploration. The copy deadline for the next issue is **January 3, 2005**. Articles or announcements should be submitted via e-mail to lpibed@lpi.usra.edu.

To be added to the mailing list to receive notification of future issues, please send your address (along with phone, fax, and e-mail), to LPIB Editor, 3600 Bay Area Boulevard, Houston TX 77058-1113, USA, or send an e-mail message to lpibed@lpi.usra.edu.

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Solicitation for Contributions

Contributions to the *Lunar and Planetary Information Bulletin (LPIB)* are solicited from the planetary community and beyond. Articles exploring issues related to planetary science and exploration are welcome. Of special interest are articles describing Web-based research and educational tools, meeting highlights and summaries, and descriptions of new space missions that may be of interest to our readers. Peer-reviewed research articles, however, are not appropriate for publication in the *LPIB*. The *LPIB* is published quarterly and serves the planetary research community, science libraries, educators, students, and lay readers interested in space-science-related research. Suggested topics can be e-mailed to the editors, who will provide guidelines for formatting and content.

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In Memoriam

Fred L. Whipple, Expert on Comets, Dies at Age 97

Dr. Fred Lawrence Whipple, the world's foremost authority on comets, died on August 30, 2004, in Cambridge, Massachusetts. He was 97. Whipple received his undergraduate degree in mathematics from the University of California at Los Angeles before declaring that math was too boring. Astronomy, for him, held a universe of possibilities. In 1931 he earned a doctorate in astronomy from the University of California at Berkeley. Whipple immediately took a position at the Harvard College Observatory, eventually becoming the Phillips Professor of Astronomy there. In 1955 he took over the directorship of the Smithsonian Astrophysical Observatory (SAO), which he helped move to Cambridge from Washington, DC. When he retired from the directorship in 1973, the SAO was merged with the Harvard College Observatory to create the Harvard-Smithsonian Center for Astrophysics. In large part due to his vigor and talent, the center is today considered one of the world's top organizations for astronomical research. He was the first to hire a young Carl Sagan for the faculty at Harvard, before Sagan joined the Cornell faculty. Joseph Veverka, the current chair of Cornell's astronomy department, was Whipple's last graduate student at Harvard.

At mid-century the "sandbank model" idea that comets were loose aggregrates of material was prevalent. Whipple changed all that with his suggestion that a comet had to have a nucleus that is a "dirty snowball" of water ice, ammonia, methane, and carbon dioxide with embedded meteoritic dust. Whipple's recognition that the outgassing of the rotating nucleus would create a rocketlike thrust that could explain the nongravitational anomalies observed in cometary orbital motion, as well as explain the persistence of cometary spectra, was a conceptual leap that is considered one of the most important contributions to solar system studies in the twentieth century.

An early believer in space exploration, he invented the "Whipple shield," a device that shields spacecraft from meteoroids and other interplanetary projectiles. He was credited with creating the first space telescope, the Orbiting Astronomical Observatory. As SAO director he helped to create the Multiple Mirror Telescope on Mt. Hopkins, Arizona, a site now named the Fred L. Whipple Observatory. At the age of 92, he was selected to serve on NASA's Comet Nucleus Tour (CONTOUR), becoming the oldest researcher to accept an active role on a space mission. Had CONTOUR been successful, Whipple would have lived to realize his dream of seeing his favorite comet — Comet Encke — up close during CONTOUR's scheduled flyby in November 2003. "I'm an engineer at heart," Whipple later said. "I've been able to judge what instruments will work and what can be built. That's been the secret to my success."

Mercury Capsule Designer Max Faget Dies at Age 83

Pioneering NASA engineer Maxime Faget, who designed the Project Mercury capsule that carried the first U.S. astronauts into space and worked on every subsequent manned spacecraft including the space shuttle, died at his home in Houston, Texas, at the age of 83. Faget was one of the original 35 engineers selected in 1958 as the nucleus of the Space Task Group to carry out the Mercury project at the beginning of the space race with the Soviet Union and is credited with conceiving and proposing the development of the one-man spacecraft used in Mercury. The Space Task Force evolved into the Johnson Space Center in Houston, NASA's center for manned spaceflight. After Mercury, Faget led the initial design teams that studied the feasibility of flying to the Moon and eventually did much of the same work on the space shuttle. He left NASA in 1981 after the second shuttle flight to help found one of the early private space companies, Space Industries Inc. "He was a true icon of the space program. There is no one in space flight history in this or any other country who has had a larger impact on man's quest in space exploration," said former Johnson Space Center director Chris Kraft. As a result of Faget's work and other NASA research, President John F. Kennedy was able to commit the U.S. to a lunar landing by the end of the 1960s. In acknowledgment of his contribution, NASA Administrator Sean O'Keefe said "Without Max Faget's innovative designs and thoughtful approach to problem solving, America's space program would have had trouble getting off the ground." Faget was inducted into the National Space Hall of Fame in 1969.

NASA Mourns Loss of Original Mercury 7 Astronaut Gordon Cooper

Leroy Gordon Cooper, Jr. (Colonel, USAF, Ret.), an original Mercury 7 astronaut, died on October 4 at his home in Ventura, California. He was 77. Cooper piloted the sixth and last flight of the Mercury program and later commanded Gemini V.

"As one of the original seven Mercury astronauts, Gordon Cooper was one of the faces of America's fledgling space program. He truly portrayed the right stuff, and he helped gain the backing and enthusiasm of the American public, so critical for the spirit of exploration," said NASA Administrator Sean O'Keefe. "Cooper's efforts and those of his fellow Mercury astronauts, Alan Shepard, Gus Grissom, John Glenn, Scott Carpenter, Wally Schirra and Deke Slayton, serve as reminders of what drives us to explore. They also remind us that to succeed any vision for exploration needs the support of the American people." The youngest of the original seven astronauts, Cooper's flight in his Faith 7 spacecraft stretched the capabilities of the Mercury capsule to the limits. The mission, May 15 and 16, 1963, lasted more than 34 hours and 22 orbits. That was more than three times the longest U.S. human space flight until that time, and far exceeded the initial design capability of the capsule. During his flight, Cooper became the first astronaut to sleep in space.

Cooper and Charles Conrad Jr. flew the troubled and suspenseful third flight of the Gemini program in August 1965. The goal of the mission was to prove astronauts could survive in space long enough to perform a lunar mission. During their eight-day mission, they experienced a number of problems with power systems, thruster fuel, venting gas that caused the spacecraft to roll, and more in a seemingly unending series. But they stayed in orbit for almost 191 hours, 122 orbits in nearly eight days, and got themselves and their spacecraft back intact. In orbit, they accomplished a "shadow rendezvous" with an imaginary spacecraft, an exercise demonstrating it could be done.

After earning a bachelor's degree at the Air Force Institute of Technology in 1956, Cooper completed test pilot school at Edwards Air Force Base in California. He served as a test pilot there until he was selected as a Mercury astronaut. He left NASA and retired from the Air Force as a colonel in 1970. Throughout his life, Cooper pursued a wide range of activities, both professionally and as hobbies. Among his hobbies were treasure hunting, archaeology, racing, flying, skiing, boating, hunting, and fishing. Among his numerous awards were the Air Force Legion of Merit, the Distinguished Flying Cross with cluster, NASA's Exceptional Service Medal, the Collier Trophy and the Harmon Trophy. Cooper continued his wide-ranging interests and activities until late in his life, continuing to design and test new aircraft in Southern California. At age 71, he told a reporter "I get cranky if I don't fly at least three times a month."

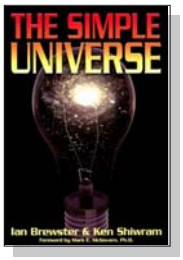
LPI Pays Tribute to Lita Kennedy Holley

Lita Kennedy Holley passed away on October 10, 2004, at M. D. Anderson Cancer Center in Houston, Texas, after a courageous battle with lymphoma. Lita was on staff at the Lunar and Planetary Institute in Houston from 1986 until 2000, coordinating administrative logistics in the support of peer review panels for NASA Headquarters. Over the course of her 14 years at the Institute, Lita made a tremendous contribution to the planetary science community, expertly handling logistics and coordinating the peer review process for literally thousands of proposals submitted to many of the major programs under the purview of NASA's Office of Space Science (Code S), including the Lunar and Planetary Review Panel (later renamed the Lunar and Planetary Geosciences Review Panel, then split into Planetary Geology and Geophysics and Cosmochemistry) and Origin of Solar Systems Review Panel. She also provided meeting coordination and logistical administration for numerous scientific conferences and workshops sponsored by the LPI. Her contribution to the community was widely recognized, not only for her superb efficiency and organization skills, but also for the tremendous warmth and good will that she always extended to others. "Lita was a gem," remembers Dr. Stan Peale of the University of California–Santa Barbara, a frequent member of numerous review panels that met at the LPI during the 1980s and 1990s. "I enjoyed seeing her each time I visited the LPI as a panel member. She helped us on panel reviews with her efficient operation, and her wonderful disposition made her a pleasure to talk to. She was such a fine person." Peale's sentiments were echoed throughout the community as scientists received the news of her death. Perhaps her character is summarized most fittingly in ancient text taken from the Old Testament: "A [woman] of noble character, who can find? She is worth far more than rubies" (Proverbs 31:10). Lita was truly a woman of noble character, and her life served as an inspiration to others. She will be missed.

New and Noteworthy

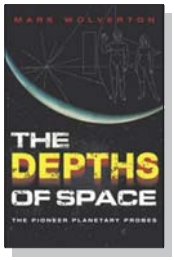
These products are available from booksellers or the publisher listed.
Please note that the LPI does not offer these products through its Order Department.

Books



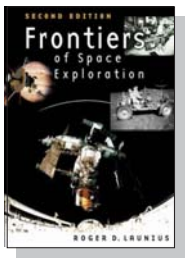
The Simple Universe. By Ian Brewster and Ken Shiwram. Apogee Books, 2004. 112 pp., Paperback, $21.95. *www.cgpublishing.com/apogee3.htm*

The Simple Universe presents the idea that the universe is not just evolving around us, but is also within us. Authors Brewster and Shiwram seek to enlighten by providing a historical context of humanity's never-ending quest to understand the "big questions" — our human desire to understand the universe, our place in it, and our relationships with one another. Highlighting what the world was like before and after Galileo's observations of the skies, this book provides a historical and cultural perspective without attempting to prescribe any answers. For readers who have an interest in understanding the universe, *The Simple Universe* is a good place to start because it takes a complex subject and makes it understandable.



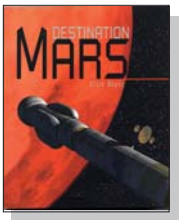
The Depths of Space: The Story of the Pioneer Planetary Probes. By Mark Wolverton. National Academies Press, 2004. 256 pp., Hardcover, $24.95. *www.nap.edu*

The first spacecraft to explore the secrets of the Sun, Jupiter, Saturn, and the void beyond Pluto, the Pioneer space probes have been the trailblazers of the space age, truly going where no man has gone before. Perhaps the most efficient, reliable, and cost-effective program to ever come out of NASA, the Pioneer missions are a shining example of how a small and talented group of people can, against all odds, accomplish something that has never been done before. More than thirty years after its launch in 1972, Pioneer 10 is still cruising into interstellar space, sending back data as it courses through the galaxy, while Pioneer 6, in solar orbit, is more than 35 years old and is humankind's oldest functioning spacecraft. Despite their enduring contributions, the Pioneer project remains a footnote in space history, little more than a humble prologue to its inheritors. *The Depths of Space* recounts the long overdue history of Pioneer both as a scientific and technological achievement and as the story of the people who made the program possible.



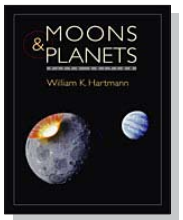
Frontiers of Space Exploration, 2nd edition. By Roger D. Launius. Greenwood Press, 2004. 304 pp., Hardcover, $45.00. *www.greenwood.com*

Since the first rocket-technology experiments of the early twentieth century, space exploration has captivated the world. Recent advances and setbacks have included the new discoveries from the Galileo mission, the Mars Global Surveyor's revelation that water once existed on the Red Planet, the success of the International Space Station, the advent of space tourism, and the devastating space shuttle disasters. Originally published in 1998, the second edition updates the chronologies and adds an article on the space shuttle. This reference guide to space exploration provides a wealth of information for student researchers.



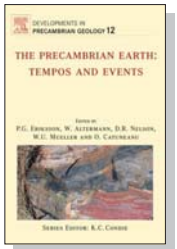
Destination Mars. By Alan Dupas. Firefly Books Ltd., 2004. 168 pp., Hardcover, $29.95. *www.fireflybooks.com*

Because of its proximity and fiery appearance, no other planet in our solar system has so fantastically captured our imagination like Mars. NASA regards Mars as the prime objective for space exploration in the twenty-first century, and it is there scientists hope to find answers to many questions about the origins of life. Destination Mars recounts the history of the timeless fascination we have had with the Red Planet and summarizes the discoveries made by the Babylonians, Egyptians, Greeks, Romans, as well as contemporary astronomers. Topics covered include the discovery of Mars, Mars as depicted in literature and the movies, traveling to Mars, life on Mars, and the future of Mars. Also discussed are the preparations for the first manned voyage to Mars planned to launch in 2015. Using fresh perspectives based on actual scientific applications and dramatic images captured by telescopes and probes, the book describes the various strategies for installing a base and developing a permanent colony there.



Moons and Planets, 5th edition. By William K. Hartmann. Brooks/Cole Publishers, 2004. 456 pp., Hardcover, $115.95. *www.brookscole.com*

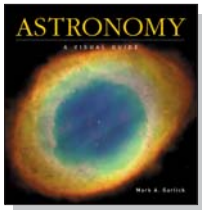
Fully updated by William Hartmann, this text retains a comparative approach to the principles of planetology, including organization by physical topic rather than by planet. This unique approach promotes an understanding of the unifying principles and processes that cause similarities and differences among the moons and planets. This edition features finding and photos from Mars Pathfinder, Mars Global Surveyor, and the Hubble Space Telescope; photos of Jupiter's atmosphere from the Galileo probe; new data on Pluto and other small bodies; and more. The text's unique math boxes provide the flexibility of teaching planetary science at a descriptive level or at a moderately advanced level involving algebra and elementary calculus.



The Precambrian Earth: Tempos and Events. Edited by P. G. Eriksson, W. Altermann, D. R. Nelson, W. U. Mueller, and O. Catuneanu. Elsevier Science Ltd., 2004. 968 pp., Paperback, $98.00. www.elsevier.com

This book covers all primary (i.e., non-applied) topics in Precambrian geology from the different, sometimes highly divergent viewpoints of a large team of international authors. Topics covered include celestial origins of Earth and succeeding extraterrestrial impact events; generation of the continental crust and the greenstone-granite debate; the interaction of mantle plumes and plate tectonics over Precambrian time; Precambrian volcanism, emphasizing komatiite research; evolution and models for Earth's hydrosphere and atmosphere; evolution of life and its influence on Precambrian ocean chemistry and chemical sedimentation; sedimentation through Precambrian time; and the application of sequence stratigraphy to the Precambrian rock record. The final chapter blends the major geological events and rates at which important processes occurred into a synthesis, which postulates a number of "event clusters" in the Precambrian when significant changes occurred in many natural systems and geological environments. This is Volume 12 of the series *Developments in Precambrian Geology.*

OBSERVER'S AIDS FROM FIREFLY BOOKS!



Astronomy: A Visual Guide. By Mark A. Garlick. Firefly Books Ltd., 2004. 304 pp., Hardcover, $29.95. www.fireflybooks.com

This book is an introductory and comprehensive guide to observing and understanding the night sky and provides a survey of science's growing understanding of space, including details of the latest space probes. Topics covered include distant stars, planets of the solar system, comets and shooting stars, eclipses, and black holes. The most recent photographs from the world's finest observatories and space-based cameras are featured, capturing the wonder and beauty of the universe. *Astronomy: A Visual Guide* also has monthly sky charts, sky maps, and planet profiles, making it an easy-to-use illustrated reference for amateur astronomers of all levels.

Sun Observer's Guide. By Pam Spence. Firefly Books Ltd., 2004. 160 pp., Paperback, $14.95.
Moonwatch: A Complete Starter Pack for the Lunar Observer. By Peter Grego. Firefly Books Ltd., 2004. Moon map, guide, and poster, $24.95. www.fireflybooks.com

These two practical publications provide an ideal starting point for amateur astronomers. The *Sun Observer's Guide* explains how to safely observe the Sun: what to look for and how to record and photograph solar images and eclipses. The book is written in non-technical language and is ideal for novice observers. Images taken by solar spacecraft are featured. *Moonwatch* is a convenient combination of three useful items for observing the Moon, including a Moon Observer's Guide book, highly detailed map of the Moon's nearside, and a photographic poster showing the lunar phases.

MISCELLANEOUS ITEMS

The History Channel Presents: The Race to the Moon DVD. Presented by the History Channel, A&E Home Video, 2004. Two-disk set, total running time four hours, $29.95. store.aetv.com

On July 20, 1969, Neil Armstrong took humankind's first steps on the Moon. Roughly one billion awestruck people watched the lunar landing on television, but very few realized how close it came to disaster. *The Race to the Moon* combines top programming from A&E and the History Channel to deliver the ultimate thirty-fifth anniversary celebration of this world-changing event. Experience the ultimate insider's view of the Apollo space program by the man who served as NASA's primary flight director for over 30 years, and examine recently declassified documents revealing NASA's plans to send men to Saturn by 1970. Take a nostalgic trip with Mike Wallace back to the early days of the space program, and return to the present-day triumphs and tragedies of one of our greatest technological achievements — the space shuttle. This two-volume DVD set features the programs "Failure Is Not An Option," "Modern Marvels: Apollo 13," "History Undercover: Code Name: Project Orion," and "Modern Marvels: The Space Shuttle."

Mars Exploration Rover Model. Produced by Code 3 Collectibles, 2004. 6.5" × 9" × 6", $150.00. www.code3.net

The Code 3 product development team worked closely with engineers from NASA's Jet Propulsion Laboratory (JPL) to duplicate the rovers that landed on Mars in January 2004. This Mars Exploration Rover model is a 1/10th-scale reproduction of the twin Spirit and Opportunity robotic geologists that have been exploring two different areas on Mars. Model details include an extending arm, a rotating high-gain antenna, movable solar panels, movable wheels, and authentic NASA and JPL logos. Made of resin and die-cast, each model comes with a limited edition certificate and martian landscape base. Mercury, Gemini, and Apollo space replicas are also available.

ONLINE RESOURCE

Science Fiction Stories with Good Astronomy & Physics: A Topical Index. Compiled by Andrew Fraknoi. Online resource. *www.astrosociety.org/education/resources/scifi.html*

The Astronomical Society of the Pacific has made available on their Web site a selective list of short stories and novels that use more-or-less accurate science and can be used for teaching or reinforcing astronomy or physics concepts. Both traditional "science-fiction" and more serious fiction that derives meaning or plot from astronomy or physics ideas are featured. The topical index includes space travel, dark matter, particle physics, asteroid and comet impacts, and the search for extraterrestrial intelligence and life elsewhere.

FOR KIDS

Lunar Lander 4-D Puzzle. By Daron Worldwide Trading, 2004. 37 puzzle pieces. Ages 6 to adult, $6.95. *www.airplaneshop.com*

Consisting of 37 pieces, this 4-D space puzzle ("3-D plus details") makes a highly detailed, collectible quality Apollo Lunar Module that stands about 3 inches tall. Challenging and fun! Instructions are included. Other puzzles in this 4-D series include Apollo command module, Saturn V rocket, and astronaut.

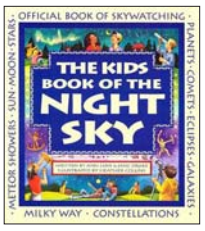
Bill Nye the Science Guy: Space Exploration DVD. From Disney Educational Productions, 2004. 26 minutes plus features. Ages 10 to adult, $49.95. *dep.disney.go.com/educational/billnye*

In "Space Exploration," Bill Nye the Science Guy explores the "final frontier" and shows the tools humans create to explore space. Did you know it takes 100 tons of fuel for a rocket to orbit the earth? Meet Dr. Linda Horn, a NASA scientist who helped develop the Cassini spacecraft. Destination: Saturn! In addition to the complete 26-minute episode of "Space Exploration," this disk has several DVD features, including fully indexed "chapters" correlated to National Science Standards, interactive glossaries and quizzes, bonus footage of never-before-seen segments, interviews, and demos, and Spanish translation and closed-captioning. (Originally released in VHS videotape format in 1997.)

Robosapien. Developed by Mark Tilden, from WowWee International, 2004. Fourteen-inch tall figure. Ages 6 to adult, $99.95. *www.robosapienonline.com*

Robosapien is a people-friendly, full-function, fast-moving programmable robot built with dynamic resonance technology, which allows it to walk on two legs with ease, just like humans. Designed by Mark Tilden, a NASA robotics physicist, this 14-inch robot controlled by wireless remote control is packed full of realistic features, including real multispeed fast dynamic walking, running, and turning and fast, full-function arms with two types of grippers. Robosapien has 67 pre-programmed functions including throwing, picking up, sweeping, dancing and various martial-arts moves, and four program modes for more advanced operations. No computer is required and the unit runs on regular batteries for over six hours. Robosapien is simple enough for kids but advanced enough for adults — it's like having a video game character for the home!

The Kids Book of the Night Sky. By Ann Love and Jane Drake. Kids Can Press, 2004. 144 pp., Hardcover, $19.95. *www.kidscan.com*



In *The Kids Book of the Night Sky*, boys and girls will discover all the secrets the night sky holds. They can play games like "Night Sky I Spy," keep an astronomer's log, and read about night sky myths. Star maps are included for each season — so kids will know what to look for, when, and where. Then as the Sun goes down and the sky goes dark, they'll be ready for the night sky's all-star show! This book is appropriate for readers 8 to adult and will provide family fun and education.

Calendar 2004

Information was valid as of this issue's publication and is subject to change without notice. For more information see the Web sites listed.

November

7–10 2004 GSA Annual Meeting and Exhibition, Geoscience in a Changing World. Denver, Colorado. *http://www.geosociety.org/meetings/2004/*

8–11 Workshop on Chondrites and the Protoplanetary Disk, Kaua'i, Hawai'i. *http://www.lpi.usra.edu/meetings/chondrites2004*

8–12 36th Annual DPS Meeting, Louisville, Kentucky. *http://dps04.org/*

9–12 The Spritzer Space Telescope, Pasadena, California. *http://ssc.spitzer.caltech.edu/mtgs/newviews/*

14–19 International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), Pucón, Chile. *http://www.iavcei.org/*

16–17 Sun-Earth Connection Physics: The GeoImpact of CMEs, CIRs, and Ordinary Solar Wind, Merida, Mexico. *http://www.lanl.gov/csse/merida*

22–25 4th European Workshop on Exo/Astrobiology "Life in Extreme Environments," Milton Keynes, UK. *http://physics.open.ac.uk/eana/*

22–Dec. 3 XVI Canary Islands Winter School of Astrophysics, Canary Islands, Spain. *http://www.iac.es/winschool2004/info.html*

December

13–17 22nd Texas Symposium on Relativistic Astrophysics at Stanford University, Palo Alto, California. *http://texasatstanford.slac.stanford.edu/*

13–17 AGU Fall Meeting, San Francisco, California. *http://www.agu.org/meetings/*

January 2005

5–7 VMSG – Volcanic and Magmatic Studies Group Annual Meeting, Milton, Keynes, UK *http://www.minersoc.org/pages/meetings/VMSG/VMSG2005.htm*

7–8 1st Symposium on Magellan Science, Pasadena, California. *http://www.ociw.edu/ociw/magellan_symposium/*

9–13 205th Meeting of the American Astronomical Society (AAS), San Diego, California. *http://www.aas.org/meetings/meeting_dates.html*

10–13 43rd American Institute of Aeronautics and Astronautics (AIAA) Aerospace Sciences Meeting and Exhibit, Reno, Nevada. *http://microgravity.grc.nasa.gov/ugml/ugmltext.htm*

17–21 Spectra and Timing of Compact X-Ray Binaries, Mumbia, India. *http://www.tifr.res.in/%7Exrb2005/*

18–20 4th Asia Pacific Symposium on Environmental Geochemistry, Perth, Western Australia. *http://www.apseg4.curtin.edu.au/*

30–Feb. 1 1st Space Exploration Conference: Continuing the Voyage of Discovery, Orlando, Florida. *http://www.aiaa.org/content.cfm?pageid=230&lumeetingid=1205*

February

6–12 2005 Winter Conference on Astrophysics — Planet Formation and Detection, Aspen, Colorado. *http://www.astro.northwestern.edu/AspenW05/*

7–10 Workshop on Radar Investigations of Planetary and Terrestrial Environments, Houston, Texas. *http://www.lpi.usra.edu/meetings/radar2005/*

13–17 Space Technology and Applications International Forum (STAIF), Albuquerque, New Mexico. *http://www.unm.edu/~isnps/staif/index.html*

17–21 American Association for the Advancement of Science (AAAS), Annual Meeting, Washington, DC. *http://www.aaas.org/meetings/Annual_Meeting/*

March

7–10 From Disks to Planets: New Observations, Models and Theories, Pasadena, California. *http://msc.caltech.edu/conferences/2005/disks05/*

14–18 36th Lunar and Planetary Science Conference (LPSC), League City, Texas. *http://www.lpi.usra.edu/meetings/lpsc2005/*

14–18 Near-Field Cosmology with Dwarf Elliptical Galaxies, Les Diablerets, Switzerland *http://www.mso.anu.edu.au/IAUC198/*

PUBLICATIONS FROM LPI

EDUCATIONAL PRODUCTS

Preview all our products and resources at
http://www.lpi.usra.edu/education/products.shtml

Quantity	Code	Title	Price	Total
	S-TOUR	A SPACECRAFT TOUR OF THE SOLAR SYSTEM, THIRD EDITION **(40 slides)** ***last chance!***	$10.00	
	S-IMPACT	TERRESTRIAL IMPACT CRATERS, SECOND EDITION **(40 slides)** ***last chance!***	$10.00	
	S-SOLAR	THE SOLAR SYSTEM IN 3-D **(40 slides)** ***last chance!***	$10.00	
	S-VENUS	IT'S A DRY HEAT: THE GEOLOGY OF VENUS FROM MAGELLAN **(40 slides)** ***last chance!***	$10.00	
	S-LIFE	ANCIENT LIFE ON MARS??? **(40 slides)** ***last chance!***	$10.00	
	S-RED	THE RED PLANET: A SURVEY OF MARS, SECOND EDITION **(40 slides)** ***last chance!***	$10.00	
	S-VOLC	VOLCANOES ON MARS **(20 slides)** ***last chance!***	$10.00	
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	S-OCEANS	SHUTTLE VIEWS THE EARTH: THE OCEANS FROM SPACE **(40 slides)** ***last chance!***	$10.00	
	S-CLOUDS	SHUTTLE VIEWS THE EARTH: CLOUDS FROM SPACE **(40 slides)** ***last chance!***	$10.00	
	S-GEOL	SHUTTLE VIEWS THE EARTH: GEOLOGY FROM SPACE **(40 slides)** ***last chance!***	$10.00	
	S-CLEM	CLEMENTINE EXPLORES THE MOON, SECOND EDITION **(35 slides)** ***last chance!***	$10.00	
	S-HAWAII	VOLCANIC FEATURES OF HAWAII AND OTHER WORLDS **(40 slides)** ***last chance!***	$10.00	
	TG-3DTCD	TEACHER'S GUIDE TO THE 3-D TOUR OF THE SOLAR SYSTEM **(CD-ROM)**	$5.00	
	C-ATLAS	3-D TOUR OF THE SOLAR SYSTEM (version 2.0) **(CD-ROM)**	$10.00	
	C-SSRG-2	SPACE SCIENCE REFERENCE GUIDE, 2ND EDITION **(CD-ROM)** *FREE SHIPPING!*	$0.00	
	R-SPEC-2	ALTA REFLECTANCE SPECTROMETER **(version 2, 11 colors)** A simple classroom instrument designed to help students learn about light, color, and spectroscopy. The ALTA handheld spectrometer weighs only 9 ounces. **(scientific instrument)**	$160.00	
	B-RSPECTG	ALTA REFLECTANCE SPECTROMETER CLASSROOM LESSONS **(book)**	$25.00	
	C-RSPECTG	ALTA REFLECTANCE SPECTROMETER CLASSROOM LESSONS **(CD-ROM)**	$5.00	
	C-CLA	CONSOLIDATED LUNAR ATLAS **(CD-ROM)**	$10.00	
	C-LOPA	DIGITAL LUNAR ORBITER PHOTOGRAPHIC ATLAS **(DVD)**	$10.00	
	C-LMC	LUNAR MAP CATALOG **(CD-ROM)**	$10.00	

OTHER PUBLICATIONS

AVAILABLE FOR THE COST OF SHIPPING AND HANDLING

	CB-1063	THIRD ANNUAL HEDS-UP FORUM **(book)**	$0.00	
	CB-1084	FORUM ON INNOVATIVE APPROACHES TO OUTER PLANETARY EXPLORATION 2001–2002 **(book)**	$0.00	
	CB-1095	CONFERENCE ON THE GEOPHYSICAL DETECTION OF SUBSURFACE WATER ON MARS **(book)**	$0.00	
	CB-1106	FOURTH ANNUAL HEDS-UP FORUM **(book)**	$0.00	
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	CB-1195	WORKSHOP ON EUROPA'S ICY SHELL: PAST, PRESENT, AND FUTURE **(book)**	$0.00	
	CB-1203	OXYGEN IN THE TERRESTRIAL PLANETS **(book)**	$0.00	
	C-33	LPSC XXXIII ABSTRACTS **(CD-ROM)**	$0.00	
	C-1184	THIRD INTERNATIONAL CONFERENCE ON MARS POLAR SCIENCE AND EXPLORATION **(CD-ROM)**	$0.00	

more selections on next page...

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