

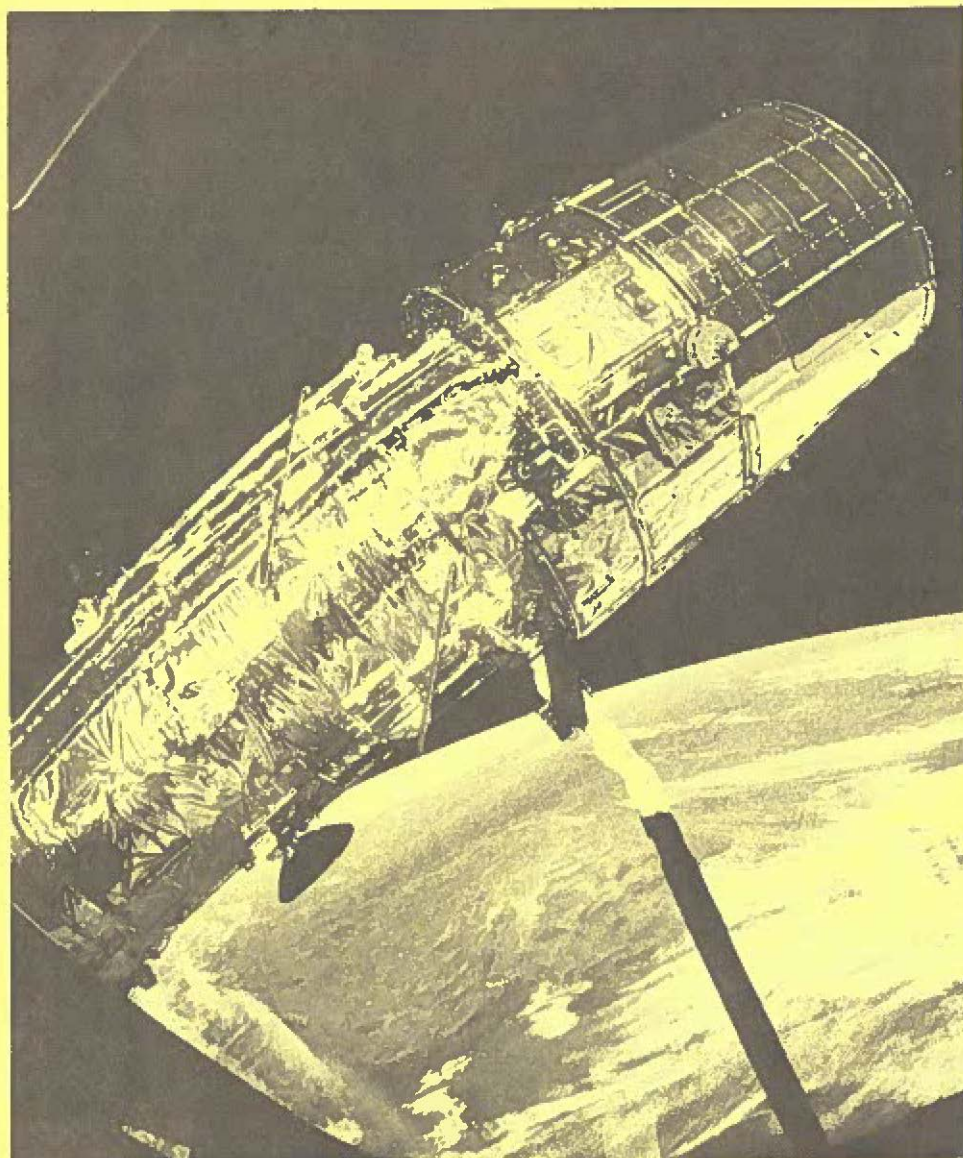
LUNAR AND PLANETARY



# INFORMATION BULLETIN

MAY 1990 • NUMBER 56

## Hubble Space Telescope Emerges ...At Last!



### Characteristics of the Space Telescope

Length of spacecraft:	13.3 m (43.5 ft.)
Diameter of spacecraft:	4.3 m (14 ft.) with solar panels stowed; 12 m (40 ft.) with solar panels deployed
Weight of spacecraft:	11,000 kilograms (24,000 pounds)
Primary mirror diameter:	2.4 m (94.5 in.)
Secondary mirror diameter:	0.3 m (12 in.)
Total effective focal length:	58 m (190 ft.)
Orbital altitude:	about 600 km (375 mi.)
Speed in orbit:	29,000 km/hr (18,000 mph)
Time for one orbit around the Earth:	95 minutes
Maximum brightness of ST seen from Earth:	magnitude -3
Instruments:	Faint Object Spectrograph
Wide Field and Planetary Camera	High Speed Photometer
Faint Object Camera	Fine Guidance Sensors
High Resolution Spectrograph	

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# LPSC Past and Future

The Twenty-first Lunar and Planetary Science Conference was held in Houston, Texas at the Johnson Space Center on March 12-16, 1990, as 760 attendees from 17 countries gathered to share scientific results given in 706 abstracts published in *Lunar and Planetary Science XXI*.

To accommodate the large number of papers, four concurrent sessions were held Monday through Wednesday mornings, and three concurrent sessions met during mornings and afternoons for the rest of the conference.

In addition to the science sessions, several evening sessions were open to the public and included a discussion of the Moon/Mars Initiative and Voyager II: A Look Back.

A summary of the conference by Dr. Michael Duke will be published in a forthcoming issue of *Geotimes*.

Copies of the abstracts are still available from the Order Department at the LPI. Please see the centerfold order form for price information.

Also available from the LPI are the *Proceedings of the Twentieth Lunar and Planetary Science Conference*, from the conference held in March 1989. Order information for this book is also on the order form.

## Mark Your Calendar Now!

The 22nd Lunar and Planetary Science Conference will be held in Houston, Texas, at the Johnson Space Center, **March 18-22, 1991**. Abstracts are due at the LPI Publications Services Department not later than **January 11, 1991** (please note that this deadline is approximately a week earlier than usual). This conference is the major gathering of scientists in the field of planetary science and serves as the forum for exchange of research results between many disciplines. To obtain more information about LPSC XXII, contact Pamela Jones, LPI, 3303 NASA Road 1, Houston, TX 77058 (713 486-2150).

## Deadline for Revised Proceedings Papers

Contributors to the 21st *Proceedings* who plan to attend the Meteoritical Society meeting in Australia in September should plan to send their revised papers to LPI Publications Services *before* leaving for the land down under. Revised papers received after mid-September will not be in time to be included in the volume.

## Available from Cambridge University Press

The following volumes are available from Cambridge University Press, Order Department, 510 North Avenue, New Rochelle, NY 10801 (Phone: 800-872-7423

or 914-235-0300). Outside North America, please order from Cambridge University Press, Customer Services Department, Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU, U.K. (Phone: 223 312393):

*Proceedings of the Nineteenth Lunar and Planetary Science Conference*

Edited by Graham Ryder and Virgil L. Sharpton

ISBN 0-521-37409-X 784 pages  
\$100/65£

Publication date: March 1989

*Proceedings of the Eighteenth Lunar and Planetary Science Conference*

Edited by Graham Ryder  
ISBN 0-521-35090-5 753 pages  
\$65/60£

Publication date: March 1988

## LPSC XXI Abstract Evokes Comment

A number of individuals, both female and male, expressed concern regarding artwork that appeared in association with a particular paper in the abstract volume from the Twenty-first Lunar and Planetary Science Conference. Many individuals were critical of the Program Committee for allowing that graphic to be included in the published volume.

It must be pointed out in fairness that most of us on the Program Committee were unaware of the image until the abstract volume was printed, and some may be unaware of it at this time. This is a consequence of the fact that each member of the Committee did not have time to review all of the more than 700 abstracts that were submitted to the Conference.

As Co-Chairman of the Program Committee, I wish to extend my apologies to those who were offended by the illustration in question, and to assure everyone that we will increase our collective sensitivity to inappropriate, non-scientific aspects of abstracts that are submitted to future Conferences.

David C. Black



Scientists attending the 21st LPSC participated in informal discussions as well as formal sessions.

The LUNAR AND PLANETARY INFORMATION BULLETIN is published three times a year by the Lunar and Planetary Institute, 3303 NASA Road 1, Houston, Texas, 77058-4399.

Fran Waranius, Editor

Editorial and production support were provided by the LPI Publications Services Department. Copy deadline for the November issue of the *Bulletin* is October 15, 1990. Send articles or announcements to be included to F. Waranius, ed., 3303 NASA Road 1, Houston, TX 77058-4399.



# LDEF Examination Continues

The goal of the Meteoroid and Debris Special Investigation Group (M&D SIG) is to make maximum use of the LDEF satellite to characterize the natural meteoroid and manmade debris environment in low-Earth orbit. Approximately 40% of the surface of LDEF is dedicated to M&D experiments. However, characterizing the largest dust and debris particles requires examining the exposure history of the entire LDEF. The LDEF meteoroid and debris experiments do not face in all directions, nor were the same materials exposed in all directions, both of which are required for determining the velocity/trajectory of dust and debris.

To augment the examinations of the meteoroid and debris principal investigators (PIs), the M&D SIG is (1) characterizing the large ( $>0.5$ -mm) impact features from the entire LDEF satellite, (2) acquiring and analyzing impact features of critical LDEF surfaces from selected experiments that were not dedicated to meteoroid and debris studies, (3) creating and maintaining a comprehensive database of impact features from the entire LDEF (results from both the M&D SIG and LDEF PIs), and (4) curating selected, representative LDEF surfaces, permitting future analysis of impact features.

To accomplish the first goal, members of the M&D SIG working at Kennedy Space Center (KSC) have video-documented all large impact features on LDEF trays and frame, down to the last bolt and washer. Documentation of experiment trays and the LDEF frame has been completed, and only a few odd pieces remain to be examined. Several thousand large impact features have been located and their stereo images recorded. Preliminary results from this impact feature study confirm that the satellite was slightly turned in orientation, so that the ram (apex) direction was located between rows 9 and 10. At least one large (0.5-mm-diameter) impact feature has been located within the satellite, the impactor having apparently entered through a thin opening in the frame.

One LDEF PI, Dr. J.A.M. McDonnell, University of Kent, reported preliminary results of his microabrasion experiment at the 21st Lunar and Planetary Science Conference, held in March at the Johnson Space Center. This experiment consisted of 5- to 30- $\mu$ m aluminum foil particle capture

cells facing in the apex and antapex directions on LDEF. It was designed to separate very high velocity particles that penetrated the 30- $\mu$ m foil (meteoroids for the most part) from those having lower velocities (a combination of both natural and manmade particulates). Particle residue composition can then be used to distinguish between sources for the latter population of particles. The apex/antapex ratio of impact populations should also be a very sensitive indicator of the relative number of higher-velocity particles (i.e., not gravitationally bound to the Earth) to those that are orbiting at lower velocities relative to LDEF. Orbiting particulates cannot reach the antapex surfaces of LDEF unless their orbital eccentricity is high, and therefore the impact features are expected to be greatly concentrated on the apex-facing LDEF surfaces. Preliminary surveys indicate that this concentration is a factor of 10 to 20 more than the number of impact features on the antapex-facing surfaces.

The analysis of the stereo video images resulting from this work, when added to the results obtained by LDEF PIs, will determine the meteoroid and debris

population size and flux in low Earth orbit with far greater precision than was possible before. These results will also serve as a critical reference point, permitting monitoring of future changes in the orbital debris environment in low Earth orbit. These issues are critical to all spacecraft activities.

Analyses by the M&D SIG have revealed many impact features located on nonmeteoroid and debris trays that merit further detailed studies (chemical, isotopic, etc.). These detailed analyses are necessary to establish the identities and origins of individual impactor particles. In nearly every case the PIs have made arrangements for the requisite analyses to be performed, either in their own laboratories or those of the M&D SIG members. Important surfaces obtained by the M&D SIG for detailed analyses include single and multilayer thermal control blankets and foil test specimens, mirrors, composite materials, aluminum screens, painted and unpainted aluminum surfaces, aluminum tray clamps, and steel screws. The M&D SIG has attached the greatest significance to materials that were exposed in all (or most) facing directions, highly polished surfaces (permitting characterization of the smallest impactors), nonaluminum containing materials (permitting analysis of spacecraft debris material, most of which probably contains aluminum).

The database for all meteoroid and debris results from LDEF will be maintained at the Curatorial Facility, Johnson Space Center. This facility will also be responsible for curation of critical M&D SIG samples. At the completion of LDEF activities at KSC, the Curatorial Facility will publish a catalog containing a compilation of all impact feature data collected at KSC along with a description of all LDEF surfaces acquired by the M&D SIG, which will be available for analysis by qualified scientists and engineers. The catalog will be sent to all LDEF PIs and will be available on request to others as well. Together, the curated LDEF samples and meteoroid and debris database will be indispensable engineering and scientific tools well into the next century.

Requests for the Facility M&D Catalog should be directed to Michael Zolensky, Planetary Science Branch/SN2, NASA/Johnson Space Center, Houston, TX 77058.



**LDEF as viewed from Columbia just before its recapture. After 5½ years in orbit, the LDEF was retrieved just weeks before it was forecast to lose power and tumble from space. (NASA Photo S32-85-006)**

# Publications

These publications are available from the publisher listed  
or may be ordered through a local bookstore.

## From the Astronomical Society of the Pacific . . .

390 Ashton Avenue, San Francisco, CA  
94112

A new catalog of data on 18,891,291 celestial objects, compiled for use with the Hubble Space Telescope, is now available on two CD-ROM disks. The disks, which must be read by a CD-ROM player attached to a personal computer, contain information on the location, brightness, and classification of over 15 million stars and 3 million nonstellar objects (mostly galaxies). Put together to help guide the pointing of the Space Telescope as it searches for known and new objects at and beyond the limits of ground-based telescopes, the mammoth catalog includes only objects too faint for the human eye to see. The package includes the two CD-ROM disks in a protective case, software to read and display the information on Macintosh computers, software to read (but not to display) the data on IBM and compatible computers, and an introductory reading list about the Space Telescope project. The package price is \$52.95.

The award-winning television astronomy series "Cosmos," hosted by Dr. Carl Sagan, is now available in home videotape format from ASP. The series, which won the Peabody award and three Emmys, was the most watched science program in the history of public television, and introduced millions of viewers to the exploration of the universe. Available on seven 2-hour VHS format tapes, the series features crisp color taken from the original master tapes and digitally mastered hi-fi stereo sound. In addition to the original 13 episodes, the package from the Society includes a new interview with Dr. Sagan updating the series and a paperbound copy of the book *Cosmos*. The entire package is available from the Society for \$198.

A pamphlet outlining the best books of the last decade for learning about astronomy is now available from the ASP. Entitled "A Basic Astronomy Library," the annotated list includes 120 outstanding introductory books for guiding the novice to a better understanding of the universe. Its sections include books on astronomy in general, the origin of the universe, the planets, astronomy as a hobby, the search for life elsewhere, astronomy on computers, learning the constellations, and many other topics. A selected list of worthwhile children's books is also included. To receive a copy send \$3.00 to ASP.

## New Books to be Noted

**Turn Left at Orion** by Guy Consolmagno and Dan M. Davis. New York, Cambridge University Press, 1989. (LC 88-28562; ISBN 0-521-34040-X) \$22.95.

This attractive book is a guidebook for beginning amateur astronomers. The Moon, planets, and nearly a hundred deep sky objects visible in the northern hemisphere are shown as they appear in a small 50-75 mm (2-3") telescope. The book gives detailed instructions on how to find these and other objects in the night sky and what to look for when you have found them. A brief summary of the current state of astronomical knowledge about each object is also included.

This book is the first guidebook specifically designed for small telescopes. The instructions assume no previous knowledge of astronomy. People of all ages and backgrounds will enjoy this helpful book. It is like having a friendly astronomer at your elbow describing where to look and what you will see. Objects are located in terms of easily visible nearby stars, rather than the more complicated celestial coordinates. Large format drawings show exactly what the observer should expect to see.

If you have a telescope that you tried once or twice and then gave up, you may want to try again with the help of this book. There are several tables of the objects, a glossary, and an index.

**Physics and Astrophysics from a Lunar Base: First NASA Workshop**, Stanford, CA 1989. Editors: A.E. Potter and T.L. Wilson. (AIP Conference Proceedings 202) New York, American Institute of Physics, 1990. (LC 90-55073; ISBN 0-88318-646-2) \$60.00.

The concept for this workshop was to explore fundamental physics at a lunar base. It focused not only upon traditional space physics but also upon those other fundamental physics experiments that uniquely require the Moon in order to be performed. The possibility of a permanent human or man-tended presence at a mature lunar base implies several new concepts to such topics as a fundamental and high-energy physics facility; particle astronomy and particle astrophysics testbed; cosmic ray and cosmic abundance observatory; new vistas in neutrino/antineutrino astronomy; and a Moon-tethered space physics observatory.

This book will be of interest to those scientists who are looking toward the future of space physics and what can be done.

## LPI Publishes First Technical Reports of 1990

Two technical reports have been published in the first quarter of 1990 by the LPI.

*Workshop on Differences Between Antarctic and Non-Antarctic Meteorites*, edited by Christian Koeberl and William A. Cassidy, is the report of the workshop held at Vienna, Austria, July 27-28, 1989. The workshop was structured to contain sessions on chemical, isotopic,



petrological, and mineralogical studies of meteorites from the two collections; terrestrial age determinations; discussions on mass frequency distributions; relative abundances of meteorite types; and terrestrial meteorite flux rates and their possible changes with time. This report contains abstracts of papers presented at the technical sessions, together with summaries of the five sessions and a general summary of the workshop with recommendations for future work. To obtain a copy, check LPI TR 90-01 on the centerfold order form.

*Workshop on Lunar Volcanic Glasses: Scientific and Resource Potential*, edited by John W. Delano and Grant H. Heiken, was held at the Lunar and Planetary Institute, October 10-11, 1989. This workshop on lunar mare volcanism was the first since 1975 to deal with the major scientific advances that have occurred in this general subject and the first ever to deal specifically with volcanic glasses. Forty-five scientists attended and made 26 presentations. This report contains the abstracts of talks presented and a technical summary of the workshop. To obtain a copy, check LPI TR 90-02 on the centerfold order form.

## Looking For a Lunar Outpost Site

A workshop to develop a strategy for choosing the best possible location(s) for a lunar outpost was held in Houston at the Johnson Space Center, April 2-3, 1990. It was sponsored by the Office of Exploration and Technology (formerly the Office of Exploration) and JSC's Solar System Exploration Division. Thirty participants were divided into discipline working groups: astronomy, space physics, geology, geophysics, and lunar resources. Group leaders were Faith Vilas (astronomy); Andrew Potter and Tom Wilson (space physics); Mark Cintala (geology); Roger Phillips (geophysics), and Dave McKay (lunar resources). Summaries from each working group along with results of the workshop will be published by JSC. Future workshops will discuss various sites based on the strategies outlined at this workshop and suggest specific sites for the Lunar Outpost. For more information, contact Bill Lagle at 713-483-5036.

## Meetings

### Mare Volcanism & Basalt Petrogenesis

The Lunar and Planetary Sample Team (LAPST) and the Lunar and Planetary Institute (LPI) have announced a Workshop on Mare Volcanism & Basalt Petrogenesis: Astounding Fundamental Concepts Developed over the Last Fifteen Years.

The last workshop devoted solely to Mare Basalts and Volcanism was held in 1975. Many new results have been reported since then. The aim of this workshop is to evaluate research on mare basalt and glass petrogenesis during this period, noting the differences between lunar and terrestrial occurrences. Major developments include: (1) the recognition that mare volcanism is as old as 4.3 Ga; (2) that there are numerous groups of glass beads, produced by fire fountaining, that require unique source regions; (3) the discovery of new basalt types (e.g., VHK from Apollo 14 and the "Group D" from Apollo 17); and (4) the application of new petrogenesis and volcanism. Discussion of these astounding, sometimes fundamental concepts in a workshop setting will let participants catch up on new developments and potentially stimulate mare basalt research well into the next century.

The workshop will be held in Dallas, October 27-28, preceding the Geological Society of America Annual Meeting. General topics will include remote sensing, mare basalt and glass petrogenesis, experimental petrology, and isotope geochemistry.

Interested parties should contact Lawrence A. Taylor (Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37996), John Longhi (Lamont-Doherty Geological Observatory, Columbia University, Palisades, NY 10964), or LeBecca Simmons (LPI).

### Detecting Buried Meteorite Impact Structures

A one-day short course on "Detecting Buried Meteorite Impact Structures" is planned for Friday, November 9, 1990, at the LPI. The short course, co-sponsored by the Lunar and Planetary Institute and American Association of Petroleum Geologists, is an element of the Astrogeology Committee's continuing effort to bring together impact experts and petroleum geologists.

The short course is designed to familiarize exploration geologists with the characteristics of meteorite impact structures so they can recognize and distinguish them from other buried structures. A variety of geophysical and geological techniques will be discussed including seismic profiling, geopotential analysis, surface structures, and petrographic and geochemical data.

Dr. Virgil L. (Buck) Sharpton, short-course convener and chief speaker, has studied impact craters for the past decade and has been associated with the AAPG Astrogeology Committee's impact initiative for three years. Other speakers will include experts in meteorite impacts, exploration geologists, and geophysicists. To promote discussion, attendance will be limited to 50 participants. A \$50.00 registration will cover course notes, refreshments, and an evening banquet.

For more information, contact Buck Sharpton, LPI, 713-486-2111; to register, contact Pam Jones, LPI, 713-486-2150.

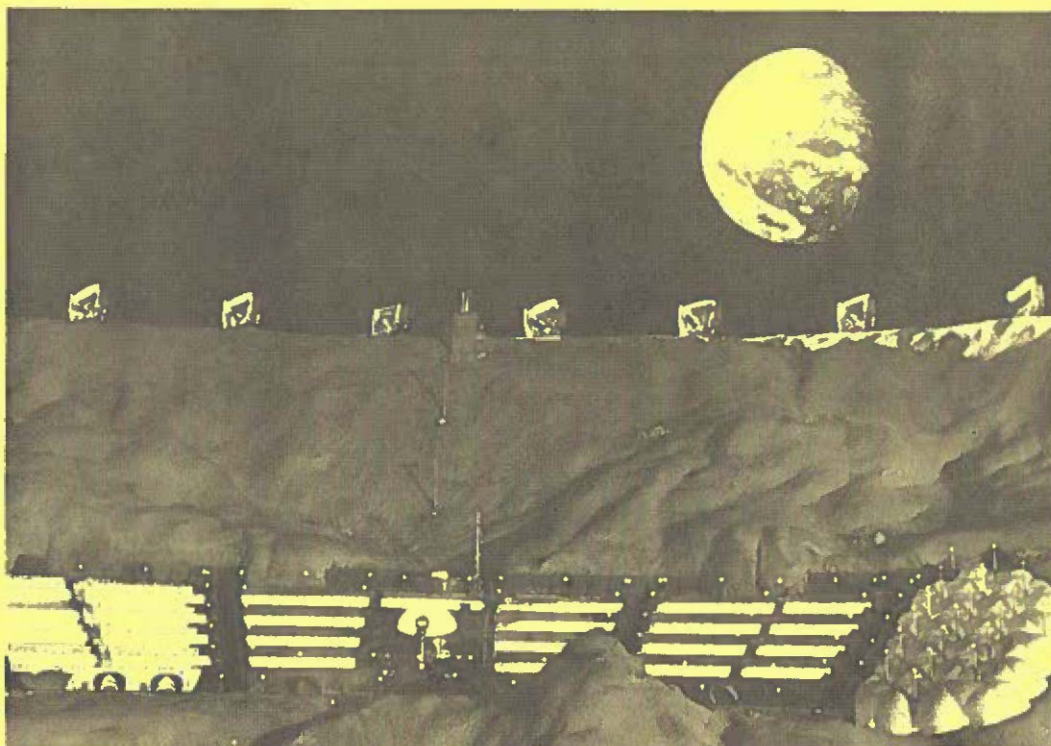
### 22nd AAS/DPS Meeting

The 22nd Annual Meeting of the Division for Planetary Sciences of the American Astronomical Society will be held in Charlottesville, Virginia, October 22-26, 1990.

Magellan will have arrived at Venus and, of course, Galileo has been there already, so results from these missions will kick off the meeting on Monday. With the planned Lunar Orbiter and Mars missions, exploration remains a vigorous activity. Therefore, there will also be special sessions on the Moon, Mars, and Neptune/Triton.

The program chairman is Alan Howard, Environmental Sciences Dept., University of Virginia, Charlottesville, VA 22901 (Phone: 804-924-0563); Local Arrangements Chairman is R.E. Johnson, School of Engineering and Applied Science, University of Virginia (Phone: 804-924-3244); Conference Director is Sandra Sullivan, School of Engineering and Applied Science, University of Virginia (Phone: 804-924-6268); and logistical support is being provided by LPI, Program Services, Pam Jones, 3303 NASA Road 1, Houston, TX 77058 (Phone: 713-486-2150).





**"Plymouth" - nestled in perpetual shadow in the crater Pythagorus, stretching out from the colony's town center, are living and working quarters, agricultural operations, and tropical forest biome. To the far right is the colony's construction zone. Solar gatherers ring the rim of the crater and the Earth rises appears in the background. © Disney**

## Let's Go Visit Plymouth

If you are interested in visiting a lunar colony, be sure to watch your TV news this fall for the airing on ABC Television of the movie-for-TV *Plymouth*.

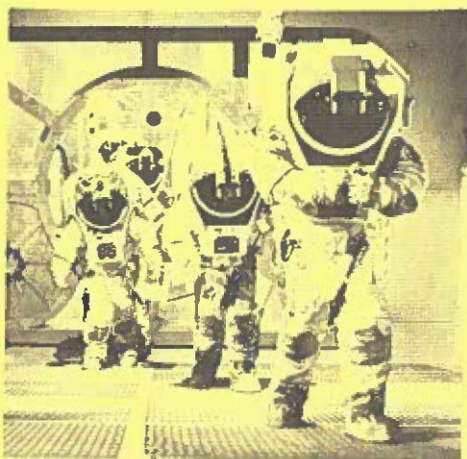
Plymouth is, or rather was, a small Oregon community that becomes uninhabitable following an industrial accident. The townspeople are transported to the Moon to become the first lunarians operating a Helium-3 plant. Rather than concentrating on the technology of such an operation, the movie deals with the people, their ability to adapt, to learn, to live in a hostile environment, and their fears of the unknown.

Cindy Pickett stars as the drama's central character, Addy Mathewson, Plymouth's town physician and a single mother with four children. Dale Midkiff as Gil Eaton is the bold charismatic engineer in charge of technical support for the lunar community who becomes romantically involved with Addy. Richard Hamilton is Wendell MacKenzie, Addy's uncle and the mayor of Plymouth who is anxious to establish secure and stable leadership for the new "lunarians."

Sets have been created to 1/96 scale and nestled into a model of the lunar crater

Pythagorus on location in nearby Saugus, California. Thirty-two miniatures, including lunar rovers and miners, have also been created in 1/96, 1/48, and 1/8 scale for use in special effects setups.

To assure authenticity, NASA experts in the area of lunar base design and



**Plymouth's technical crew entering the town corridor through a pressurized air lock.**

© Disney

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; Larry Bell and Guillermo Trotti, space architects; Dr. Carl Hodges of Environmental Research Laboratories in Tucson; and Pat Rawlings, space artist, have all contributed to the research for this film.

This reality-based drama is the first international coproduction of Walt Disney Television, RAI-Uno Radiotelevisione Italiana, and Lee David Zlotoff. Mr. Zlotoff, executive producer, writer, and director, Ralph Winter, executive producer, producer Ian Sander, and production designer Michael Baugh are striving to create the most technologically accurate show about space ever developed for television.

If you would like to help ensure that *Plymouth* becomes a weekly TV series write to ABC Television to express your support. Letters may be sent to John Barber, Vice President, Current Series Programs, ABC Television, 2040 Avenue of the Stars, Los Angeles, CA 90067.

# AVAILABLE FROM LPI



## — PROCEEDINGS —

### **PROCEEDINGS OF THE TWENTIETH LUNAR AND PLANETARY SCIENCE CONFERENCE—Virgil L. Sharpton and Graham Ryder, eds.**

This proceedings volume comprises 50 papers representing current research findings and developments in the fields of planetary science, astronomy, geochemistry, petrology, and geology. The papers are organized into the following topics: Petrology and Geochemistry of the Moon, Geology of the Moon, Lunar Regolith Processes and Resources, Petrology and Geochemistry of Achondrites, Comets and Interplanetary Dust, Shock and Terrestrial Cratering, Geology of Mars, and Geology of Venus.

**Hardcover, 610 pp., 419 figures, author, subject, meteorite, and lunar sample indexes**

**Order Code: B-PROCEEDINGS, \$50.00**

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## — BOOKS —

### **ORIGIN OF THE MOON—W.K. Hartmann, R. J. Phillips, and G.J. Taylor, eds.**

*Origin of the Moon* provides a synthesis of models and theories about the formation of the Moon. In this collection of 33 original research and review papers are the findings and contributions of both data analysts and planetary theorists. There are historical reviews covering the early history of scientific thinking as well as scenarios based on the post-Apollo views. The book includes papers discussing the traditional scenarios of capture, fission, and coaccretion. Two additional ideas—the impact-trigger model and a coaccretional “composition filter” model—are also presented. Dynamic, geochemical, and geophysical constraints are explored in detail.

**Hardcover, 800 pp., 187 figures, glossary, subject and author indexes**

**Order Code: B-ORIGIN, \$25.00**

### **LUNAR BASES AND SPACE ACTIVITIES OF THE 21ST CENTURY—W.W. Mendell, ed.**

This book contains 90 individual articles that address the various problems and opportunities associated with development of a manned base on the Moon. Also included are ideas for missions to Mars and other proposed space activities of the twenty-first century. It is an informative, referenceable text for research scientists and college students as well as interested laymen and is heavily illustrated with diagrams, photos, and artists' conceptions. As applicable to lunar occupation, the technology discussed encompasses agriculture, architecture, astronomy, engineering, economics, geology, hydrology, medicine and health, mining, manufacturing, physics, and space research.

**Softcover, 865 pp., 211 figures, subject index**

**Order Code: B-BASES, \$20.00**

### **PLANETARY SCIENCE: A LUNAR PERSPECTIVE—S. Ross Taylor**

This publication is an excellent synthesis of information on our understanding of the nature, origin, and evolution of the solar system. It addresses such topics as planetary geology and stratigraphy; meteorite impacts, craters, and multi-ring basins; planetary surfaces and crusts; basaltic volcanism and planetary interiors; and the chemical composition of the planets. In addition to the text, this book offers 24 pages of appended material. It has become a definitive reference work for the planetologist as well as the astronomer.

**Hardcover, 481 pp., 176 figures, glossary, subject index**

**Order Code: B-PLANS, \$30.00**

### **CHONDRULES AND THEIR ORIGINS—E.A. King, Jr., ed.**

*Chondrules and their Origins* contains 25 review papers and original research contributions designed to provide the reader with a broad knowledge of the most recent data regarding the origin and history of chondrules. As a resource text, it also provides an extended bibliography of 467 related papers.

**Hardcover, 375 pp., 122 figures, subject and author indexes**

**Order Code: B-CHON, \$25.00**

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## — SLIDE SETS —

**Each set includes an explanatory booklet.**

**THE WINDS OF MARS: AEOLIAN ACTIVITY AND LANDFORMS** The 30 slides in this set were selected to provide an overview of the types of aeolian activity and landforms found on Mars. With arrival of the Mariner 9 spacecraft in Mars orbit in 1971, an astonishing variety of geologic features on Mars was revealed. Most of what we know about Mars came from Viking 1 and 2 landings in 1976. Although this set is by no means all-inclusive, it does show that we are still analyzing the results of these missions and there remains much additional work to be done. (30 slides)

**Order Code: S-WINDS, \$15.00**

**A SPACECRAFT TOUR OF THE SOLAR SYSTEM** A great variety of solar system objects have been photographed during both manned and unmanned spacecraft missions. All of the slides in this set were obtained within the last 20 years and they are intended to be representative of the principle distinctive features of each planet and its natural satellites. (40 slides)

**Order Code: S-TOUR, \$17.00**

**(Over, please)**



## SLIDE SETS—*continued*

**STONES, WIND, AND ICE: A GUIDE TO MARTIAN IMPACT CRATERS** This set of 30 slides, compiled largely from Viking Orbiter and Lander images, illustrates both the diversity of impact craters on Mars and the significance of these features in understanding the geological evolution of this complex planet. Many of the landforms produced by the interaction of the cratering process with the martian environment are seen virtually nowhere else in the solar system. Impact craters also provide a means of deducing the sequence and timing of events that have shaped the martian surface. (30 slides)  
**Order Code: S-STONES, \$15.00**

**VOLCANOES ON MARS** This slide set illustrates various geologic features on Mars. The set includes some of the best examples of Viking Orbiter images that include constructional volcanic landforms. Approximately half of the slides deal with the large shield flows on the flanks of the volcanoes. The remainder of the slides show various constructs (classified as Mons, Patera, or Tholus) from the Tharsis, Elysium, and Hellas regions as well as the kilometer sized mounds that are interpreted to be of volcanic origin. (20 slides)  
**Order Code: S-VOLCA, \$12.00**

**APOLLO LANDING SITES** This set of 40 slides provides photographic coverage of the regional setting for the six Apollo landing sites. This collection shows the sites at a variety of scales ranging from Earth-based telescopic views spanning hundreds of kilometers to high-resolution photographs taken from lunar orbit. Descriptions giving geological details for each area are included in the accompanying booklet. This slide set is useful for educators and researchers who wish to show the regional setting of samples and photographs returned by the Apollo missions. (40 slides)  
**Order Code: S-APOLLO, \$17.00**

**SHUTTLE VIEWS THE EARTH: THE OCEANS FROM SPACE** This slide set offers a selection of the most fascinating and informative shuttle photographs of the oceans and features images taken with a variety of equipment. Naturally occurring sea surface features have been photographically recorded, as well as the meteorological and oceanic influences on land masses.  
(40 slides)  
**Order Code: S-OCEAN, \$17.00**

**SHUTTLE VIEWS THE EARTH: CLOUDS FROM SPACE** This slide collection includes some of the most informative and visually impressive cloud photographs taken in 24 shuttle missions. The accompanying booklet has a foreword by astronaut Robert Crippen. The unique perspective of shuttle photography helps us to understand weather patterns and the development of weather systems worldwide. (40 slides)  
**Order Code: S-CLOUD, \$17.00**

**SHUTTLE VIEWS THE EARTH: GEOLOGY FROM SPACE** Photographs of stunning geological features on the Earth have captured the attention of shuttle astronauts mission after mission. Shuttle photographs enable us to trace fault margins in the Earth's crust and observe large structures, such as meteor impact craters, in their entirety and in the context of their surroundings. The images reveal how much of the Earth's surface is covered by vast deserts and also provide comparisons of old volcanic structures with young erupting volcanoes at various locations around the world. (40 slides)  
**Order Code: S-GEOL, \$17.00**

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## — TECHNICAL REPORTS AND CONTRIBUTIONS —

Available for the cost of shipping and handling except as noted below.

**Order Code: R-86-04** WORKSHOP ON EARLY CRUSTAL GENESIS: THE WORLD'S OLDEST ROCKS. L. D. Ashwal

**Order Code: R-87-01** MECA SYMPOSIUM ON MARS: EVOLUTION OF ITS CLIMATE AND ATMOSPHERE. V. Baker, M. Carr, F. Fanale, R. Greeley, R. Haberle, C. Levey, T. Maxwell

**Order Code: R-87-02** MARTIAN GEOMORPHOLOGY AND ITS RELATION TO SUBSURFACE VOLATILES (MECA Special Session at LPSC XVIII). S. Clifford, L. Roszbacher, J. Zimbleman

**Order Code: R-87-03** MARTIAN CLOUDS DATA WORKSHOP. S. Lee

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# LPI Summer Intern Program

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The Summer Intern Program, entering its 14th year at the Lunar and Planetary Institute, is designed to introduce undergraduate students to the research environment. The 1990 program will begin on June 11 for a ten-week period with a roster of 14 students chosen from 161 applicants. From such diverse areas as Norway and Newfoundland to the Gulf shores, and from Hawaii to New York, these young people will carry out individual research projects under the direction of a scientist-advisor, culminating in a mini-conference to report the results of the summer's labor. Throughout the summer, frequent lectures and seminars by scientists in a variety of space science programs offer additional opportunity to learn about many areas of planetary science. The scientific organizers are Dr. Bruce Bills, LPI and Dr. Michael Zolensky, NASA/JSC.

If you are interested in participating in the 1991 program, send your name and address to the Program Services Department, Summer Intern Program, LPI, 3303 NASA Road 1, Houston, TX 77058-4399. You will receive application information in November 1990.

The 1990 interns, their advisors, and projects are:

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**Lauren Browning, University of Texas at Austin**

**Advisor: Michael Zolensky, NASA/JSC**

The study will involve detailed petrographic analysis of 41 carbonaceous chondrites, supplemented by analysis using the scanning electron microscope and microprobe. The goal is to reinterpret the histories of specific carbonaceous chondrites (and their parent hydrous asteroids) based on the lithologies.

**Peter McCarthy Bryant, University of Chicago**

**Advisor: Bruce Bills, LPI**

The moment-of-inertia of Mars is an important geophysical parameter. The basic strategy of this project is to use all of the available data types (tracking data for Mariner 9 and the two Viking orbiters, range data for the two Viking landers, and astrometric observations of Phobos and Deimos) to solve for improved estimates of all the relevant parameters (orbital parameters of the natural satellites, low degree gravity harmonics, and spin axis direction and precession rate of Mars).

**David J.P. Foss, Colgate University**

**Advisor: Shanaka de Silva, LPI**

The combination of excellent preservation and tight chronological control makes Askja volcano, Iceland, an excellent place to study the evolution of a major basaltic magmatic system with implications for both terrestrial and extra-terrestrial magmatic systems. This research project will study major petrographic and microprobe samples from the various eruptive episodes at Askja to produce an integrated evolutionary model.

**John Robert Fredericks, Kings College**

**Advisor: Everett K. Gibson, NASA/JSC**

This project involves work on determining the nature of the gases associated with lunar volcanism. Selected lunar soils containing large proportions of glass beads will be examined and those glass beads that might be hollow will be handpicked. These glass spheres will be opened with the laser microprobe and released gases analyzed with a quadrupole mass spectrometer. Results will be compared with expected theoretical values obtained from gas-phase thermodynamic calculations based upon the mineral relationships present within lunar basalts at the sites where the beads originated.

**Donald Gable Hervey Jr., Texas A&M University**

**Advisor: Don L. Henninger, NASA/JSC**

The proposed research is to expose simulated lunar regolith (both glass and mineral components) to various concentrations of humic and fulvic acids extracted from a terrestrial soil and to analyze aliquots taken at periodic intervals for concentration of elements using an atomic absorption spectrophotometer. This research will further investigations into the use of a lunar regolith as a potential plant growth medium.

**Anthony James Kettle, Memorial University of Newfoundland**

**Advisor: James Gooding, NASA/JSC**

Differential scanning calorimetry (DSC) is an analytical method that will probably fly for the first time on the Comet Rendezvous and Asteroid Flyby (CRAF) mission. A more elaborate experiment has been identified as a high priority for future robotic missions to the surface of Mars. Additional data are needed to document the DSC analytical "fingerprints" of various planetary materials. The project will involve operation of the instrument, data collection and reduction, and scientific interpretation of results.

**Ragnhild Landheim, Louisiana Tech University**

**Advisor: Nadine Barlow, NASA/JSC**

The intern will use Viking imagery to identify and classify craters in the 1.5- to 8-km diameter range. The crater diameter data will be combined with existing information to produce crater size-frequency distribution curves. Analysis of these curves will allow comparisons of the studied regions to volcanoes and other events in the martian relative age chronology. Obliteration effects on the distribution curves will be noted and included in an ongoing study of the surface obliteration history of Mars.

**Robert Dean Lewis, University of Northern Iowa**

**Advisor: Gary Lofgren, NASA/JSC**

Sodium in melt droplet chondrules has presented a perplexing problem to experimentalists. In this project a chondrule-like composition will be melted at a controlled oxygen partial pressure and at the same time with an elevated sodium partial pressure. Electron microprobe analyses of the run products (using all the



necessary precautions against sodium loss) should provide adequate accuracy to determine the behavior of sodium in a closed system.

**Scott R. Messenger, University of Washington**

**Advisor: Fred Hörz, NASA/JSC**

Thermal blankets made from thin Teflon have been exposed to the space environment on the Long Duration Exposure Facility (LDEF) for 5.7 years. An examination of the penetration holes on these blankets made by both natural and manmade particles will yield information concerning the possible effects of such exposure on flight systems. This project will attempt to duplicate the penetration holes in the laboratory. These controlled experiments will serve to relate a measured penetration-hole diameter to projectile diameter and mass. In addition, dimensional measurements of the debris cloud that exits the test foil's rear surface is needed. Analysis of the debris cloud on the experimental plates may yield clues to the extent of damage that could be done to actual flight systems.

**Benjamin Mark Myers, University of Arkansas**

**Advisors: Marilyn Lindstrom and David Mittlefehldt, NASA/JSC**

The work will involve performing INAA trace element analyses on the silicate phases separated from several group IV iron meteorites, conducting electron microprobe analyses for major elements of the silicates, and performing electron microprobe analyses of the metallic phases to determine the cooling rates of a larger suite of the group IVA irons. The data will be used to constrain the origin of these iron meteorites.

**Scott Wesley Rubin, University of Texas**

**Advisor: Mark Cintala, NASA/JSC**

Experimental investigations into the catastrophic disruption of asteroids and small planetary satellites have been conducted under a variety of conditions. A parameter common to all of these studies is the fraction of the original target mass ( $M_0$ ) that is contained in the largest remaining fragment ( $M_R$ ) or  $M_R/M_0$ . In plotting this quantity against various measures of the impactor energy, however, a trend with considerable scatter in  $M_R/M_0$  invariably results, even when very strict limits are placed on experimental variables. This study will investigate possible reasons for this phenomenon with the aid of impact experiments in the JSC Experimental Impact Laboratory.

**Elizabeth Eve Shaffer, Indiana University**

**Advisor: John Jones, NASA/JSC**

The abundances of V, Cr, and Mn in the Earth and Moon have been used to bolster arguments that the Moon is derived primarily from terrestrial material. This project is to test the hypothesis that the Earth and Moon must be related genetically by experimentally determining the volatility of V, Cr, and Mn. Silicate glasses doped with V, Cr, and Mn will be placed on Pt wires and suspended in a high-temperature furnace at low oxygen fugacity. Initially, experiments will be run at temperatures of about 1400°C and oxygen fugacities near iron-wüstite (IW). Quenched experiments will then be analyzed with the electron microprobe to see if there has been a change in the V, Cr, and Mn concentrations of the charges. If V can be successfully volatilized in the laboratory, then it will be possible to explain that the V-Cr-Mn abundances of the Earth and Moon need not be related genetically, except in the most general sense.

**Kelly Gene Spencer, Texas A&M University**

**Advisor: Douglas Ming, NASA/JSC**

Zeoponics, a potentially viable solid support substrate for plant growth in regenerative life support systems, is only in its developmental stages at the Johnson Space Center. Based upon the unique properties of zeolites, the feasibility of growing plants in zeoponic systems is being evaluated. The current research effort is aimed at understanding how natural zeolites behave in zeoponic plant growth systems. The objectives of this project are (1) investigate the chemical equilibrium relationships between a synthetic zeolite and apatite, and (2) determine the feasibility of growing plants in zeoponic systems using a synthetic zeolite substrate.

**Paraluman P. Stice, University of Hawaii**

**Advisor: Steve Williams, LPI**

This project will involve counting craters and determining ages for a number of geologic units found in the southwestern part of the Utopia Planitia region of Mars, near the area being mapped for the Mars Geologic Mapping Program. The study area is important because it contains several different mantling layers whose emplacement and erosion history may be related to the formation and evolution of the nearby crustal dichotomy boundary. Accurate determination of the timing of the emplacement of the layers can constrain models of large-scale tectonic and sedimentary activity of Mars.

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## In Memoriam

Dr. Isidore Adler, known to many in the lunar and planetary science community for his work in the Apollo program, died of cancer on March 26, 1990. He was 73 years old. In addition to his work on the chemical composition of the Moon, he was co-director of the project "World of Chemistry," a 26-part national public and cable television series that will air this fall and will also be used by colleges and universities to teach chemistry.

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Ronald E. Eyans, 56, who was the command module pilot on Apollo 17, died of a heart attack April 7 at his Arizona home. He had commented that his Moon flight was "the best experience I ever had in my life." He left NASA to become an officer with Western American Energy Corp. in Scottsdale, Arizona.

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# News from Space



## Magellan Status Report -

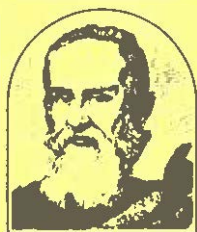
April 30

The Magellan spacecraft is 103 million miles from Earth and nearly 21 million miles from Venus. The cruise continues with all subsystems performing well. The spacecraft is traveling at 66,824 mph relative to the sun.

Cruise sequence 22 was uploaded and is being executed perfectly. It changed to a new star pair for star calibrations. They are now Beta Gruis and Alpha Aquilae. Five of the seven daily star calibrations were fully successful with an average attitude update of 0.05 degrees. Two of them, on Tuesday and Thursday, were partially successful, with single star updates. That was due to the rejection of Beta Gruis on both occasions by the star scanner unit's foreground filter. The spacecraft team is analyzing the playback data for those events.

Last week also saw the completion of memory readouts of all command data system redundant memories in both the A and B sides. No parity errors were found.

Spacecraft Distance	
from Earth (mi)	102,942,136
Velocity Heliocentric	66,824 mph
One-way light time	9 mins, 12.5 secs



## Galileo Mission Status -

April 27

The Galileo spacecraft is almost 92 million miles from Earth so that a radio signal takes 16½ minutes to go up to the spacecraft and return. Its speed in orbit around the Sun is 71,230 mph, and it has traveled almost 341 million miles since launch.

Two weeks of spacecraft tracking have confirmed that the four-day trajectory

correction maneuver completed April 12 went extremely well. The next maneuver, currently being designed, will start May 11 and take two days.

Spacecraft health continues to be generally excellent. Normal cruise activities this week have included sun-pointing turns, propulsion system maintenance, and science observations by the magnetometer, dust, and ultraviolet instruments. These activities are governed by a new operating sequence, transmitted to the spacecraft April 20 and covering the period from April 23 through June 10.

## International Ultraviolet Explorer

The International Ultraviolet Explorer (IUE) satellite, a joint undertaking of the National Aeronautics and Space Administration (NASA), the European Space Agency (ESA), and the British Science and Engineering Research Council (SERC), was launched on January 26, 1978. During its 12-year, highly successful orbital operations, this satellite, the first space observatory available to the general user, has made unequalled contributions to almost every field of astrophysics, from solar system studies to cosmology. It is expected that, in the absence of a major failure, the spacecraft will continue to support the science program through 1993.

IUE has also amassed a wealth of nearly 70,000 ultraviolet low- and high-resolution spectra of about 10,000 different astronomical objects from planets to quasars. All data obtained with the IUE enter into the public domain six months after processing. These archives, the first of their kind, can easily be accessed by any scientist who wishes to use them, for instance, for statistical or temporal variability studies. Through the ESA-developed on-line archive more than 40,000 de-archivings of low resolution spectra by 340 users from 21 countries has been supported.

To chronicle the important findings of the guest observer program of IUE data, Dr. Y. Kondo has edited *Exploring the Universe with the IUE Satellite* (Kluwer, 1989). In addition, according to the preface, by the end of 1987, a few weeks before the tenth anniversary of launch, 1471 papers had been published in refereed journals using IUE observations. During the first 10 years of IUE science operations, 832 different guest observers

used the research facilities at Goddard, while about 770 astronomers used the ground station at Villafranca.

To highlight the latest results obtained, not only from recent observations but also from archival studies, a joint NASA/ESA/SERC IUE conference, "Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions," co-sponsored by CNES and the Paul Sabatier University, will be held from 29 May to 1 June 1990 at the University of Toulouse, France. The scientific organizing committee is chaired by W. Wamsteker with Y. Kondo and R. Wilson as co-chairmen. The proceedings of the symposium will be published by ESA Publications Division (ESA SP-310) in August 1990.

## IUGS Commission on Comparative Planetology

The Commission on Comparative Planetology of the International Union of Geological Sciences was set up several years ago to promote comparative planetology in international geological sciences and to advise the executive board of IUGS on similar matters.

Some of the goals of the Commission are:

(1) to promote communication among the various bodies of IUGS and other associated bodies with respect to the application of the results of planetary studies to problems of terrestrial geology;

(2) to stimulate research projects and efforts in specific areas of significance to geology;

(3) to stimulate the application of the available data and results of planetary studies to research in geology;

(4) to advise the IUGS Executive Committee on initiatives that have and may be taken in the application of the results of planetary studies.

The Commission has 11 members from 8 countries, including James W. Head III, Chairman; A.T. Basilevsky, Vice-Chairman; and Richard A.F. Grieve, Secretary. To further the goals of the Commission, a number of microsymbiosia have been organized. The 12th Vernadsky Institute/Brown University Microsymposium will be held in Moscow, USSR, July 12-16, 1990. For more information, please contact James W. Head III, Box 1846, Dept. of Geological Sciences, Brown University, Providence, RI 02912 (Phone: 401-863-2526).



# MSATT Project Begun

by Robert Haberle

An organizational meeting, chaired by Bruce Jakosky, was held at the Lunar and Planetary Institute on March 11, 1990 to initiate the next NASA-sponsored LPI Study Project entitled "MSATT: Mars Surface and Atmosphere Through Time."

As with the previous data analysis programs, MEVTV and MECA, MSATT will run for 3 years and will function through a working group selected from the program's 31 principal investigators. Due to cutbacks in NASA's FY90 R&A program, however, funds for MSATT will not be available until the beginning of FY91 (October 1990).

The purpose of the meeting was to select a steering committee, discuss the scientific objectives of the program and how it will operate, and begin integrating related research areas by fostering interactions within the working group itself. Discussions by the working group are summarized as follows:

1. The general goal of MSATT is to investigate the processes that have developed and modified the martian surface and atmosphere through time. Based on the working group's proposed research, four areas were identified:

- current atmosphere and surface processes,
- surface chemistry and mineralogy,
- the early atmosphere and its evolution,
- the long-term geologic history of the surface.

2. The program will operate through a series of topical workshops and/or conferences that will have focused objectives. Definition of these workshops will take place following a one-day informal gathering of the working group later this year.

3. The following steering committee was elected:

- Robert Haberle, NASA/Ames, Chairman (Current Atmospheric Processes)
- Janet Luhmann, UCLA (Early Atmosphere and Evolution)
- Kenneth Tanaka, USGS (Geologic History)
- Steven Lee, LASP (Current Surface Processes)
- Roger Burns, MIT (Surface Chemistry and Mineralogy)

Also serving on the committee are:

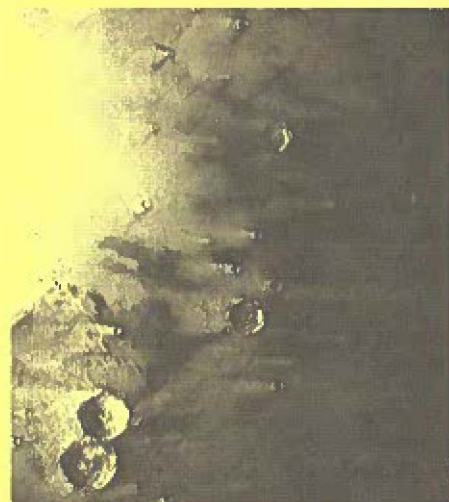
- Ben Schuraytz, LPI (Project Scientist)
- Pam Jones, LPI (Project Administrator)
- Joseph Boyce, NASA Headquarters, (ex officio)

4. MSATT activities (workshops, conferences, publications, etc.) should be open to all investigators willing to contribute toward program goals, whether funded by MSATT or elsewhere.

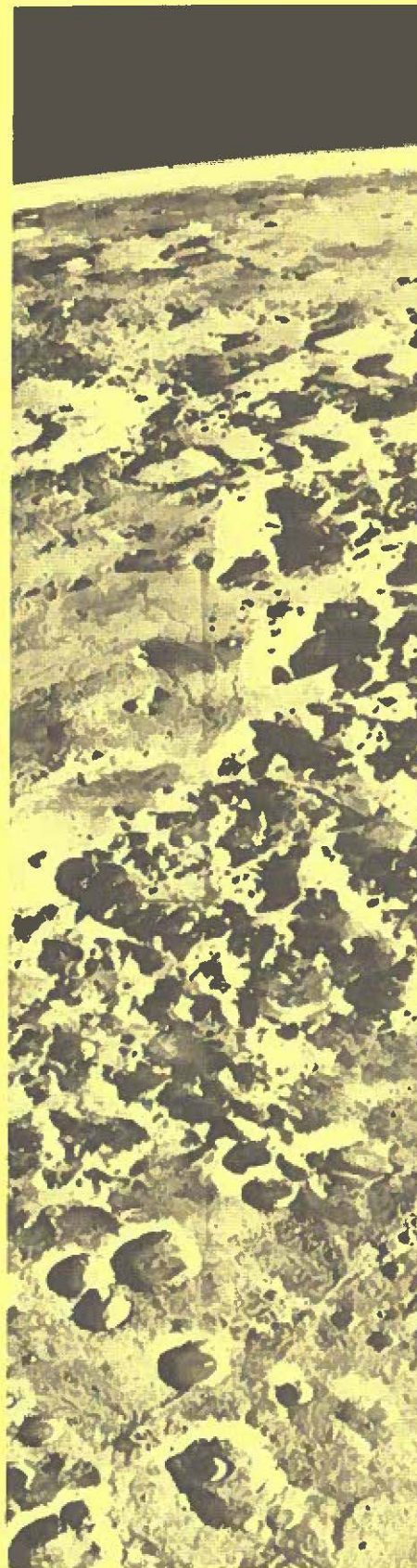
5. Research will be conducted by individual investigators as proposed. However, collaborations are strongly encouraged as much of the program goals are interdisciplinary in nature.

6. Since the goals of the MSATT program are directly relevant to the Space Exploration Initiative (SEI), some line of communication between MSATT and SEI should be established. Since several MSATT PIs are also members of the Mars Science Working Group (Mike Carr, Chair), that line of communication is already in place, but should be reinforced.

It was generally felt that MSATT promises to be a stimulating program. It will bring together scientists with diverse backgrounds and interests and will address very exciting and timely topics. However, there was justifiable concern over the funding situation. Hopefully, these difficulties can be resolved so that MSATT's full potential can be realized.



Dark and light streaks on the surface of Mars result from winds that interact with topographic obstacles such as the rims of impact craters. The different orientations of the wind streaks indicate that the two streak types are formed under differing wind conditions, most likely during different parts of the martian seasonal cycle. (Viking Orbiter I image 496A47)



The Aryg्रे Basin on Mars showing old heavily cratered terrain. (NASA S.76-27774)



# Calendar

## June

- 4-8 **Mars and Venus: Atmospheres, Ionospheres, and Solar-Wind Interactions (Chapman Conference)**, Balatonfured, Hungary. Contact: AGU Meetings, 2000 Florida Avenue NW, Washington, DC 20009. Phone: 202-462-6900.
- 4-8 **The Case for Mars IV**, Boulder, Colorado. Contact: Tom Meyer, Case for Mars IV, P.O. Box 4877, Boulder, CO 80306. Phone: 303-494-8144.
- 23-July 7 **XXVIIIth COSPAR Meeting and associated activities including the VIIth International Symposium on Solar-Terrestrial Physics**, Netherlands Congress Centre, The Hague, Netherlands. Contact: Dr. Z. Svestka, SRON, Beneluxlaan 21, 3527 HS Utrecht, The Netherlands. Phone: (+31-30)93-71-45.

## July

- 2-6 **9th International Conference on Basement Tectonics**, Canberra, Australia. Contact: IBT9 ACTS, GPO Box 2200, ACT 2601, Australia.
- 12-16 **12th Vernadsky Institute/Brown University Microsymposium on Comparative Planetology**, Moscow, USSR. Contact: James W. Head III, Dept. of Geological Sciences, Brown University, Providence, RI 02912. Phone: 401-863-2526.
- 13-15 **Astronomical Society of the Pacific, 102nd Annual Meeting**, Boston University. Includes: Symposium on Robotic Observatories (July 13-15), Symposium on Star Clusters (July 16-18), Workshop on Teaching Astronomy in Grades 3-14 (July 14-15), and The Universe Unfolding: Popular Lectures & Seminars (July 14-15). Contact: A.S.P. Meetings, 390 Ashton Avenue, San Francisco, CA 94112. Phone: 415-337-1100.

## August

- 31-September 3 **Third International Workshop on Catastrophic Disruption of Small Solar System Bodies**, Kyoto Japan. Contact: A. Fujiwara, Kyoto, Japan 606. Phone: (075)753-3851, or Don Davis, Planetary Science Institute, 2421 E. 6th St., Tucson, AZ 85719. Phone: 602-881-0332.

## September

- 17-21 **53rd Annual Meeting of the Meteoritical Society**, Perth, Australia. Contact: Dr. Alex Bevan, Department of Earth and Planetary Sciences, Western Australian Museum, Francis Street, Perth, Western Australia 6000. Phone: 09-427-2752.

## September

- 21-22 **Meteorite Impact on the Early Earth**, Perth, Australia. Contact: Pam Jones, LPI Program Services Department, 3303 NASA Road 1, Houston, TX 77058. Phone: 713-486-2150.
- 24-29 **7th International Conference on Geochronology, Cosmochronology, and Isotope Geology**, Canberra, Australia. Contact: Prof. W. Compston, Research School of Earth Sciences, Australian National University, GPO Box 4, Canberra 2601, Australia. Phone: 062-49-3406.

## October

- 5-6 **Solids in Astrophysics: A Symposium to Honor Roman Smoluchowski on his 80th Birthday**, Austin, Texas. Contact: W. D. Cochran, Dept. of Astronomy, University of Texas, Austin, TX 78712. Phone: 521-471-6474 or 471-3350.
- 22-26 **Annual Meeting of the Division for Planetary Science of the American Astronomical Society**, Charlottesville, Virginia. Contact: Bob Johnson, Department of Engineering Physics, University of Virginia, Charlottesville, VA 22903. Phone: 804-924-3244.
- 27-28 **LPI-LAPST Workshop on Mare Volcanism & Basaltic Petrogenesis: Astounding Fundamental Concepts (AFC) Developed Over the Last Fifteen Years**, Dallas, Texas. Contact: L. Simmons, LPI Program Services Department, 3303 NASA Road 1, Houston, TX 77058. Phone: 713-486-2158.
- 29-November 1 **Geological Society of America Annual Meeting**, Dallas, Texas. Contact: Sue Beggs, GSA Meetings Manager, P.O. Box 9140, Boulder, CO 80301. Phone: 303-447-2020.

## November

- 9 **Short Course on Detecting Buried Meteorite Impact Structures**, LPI, Houston, Texas. Contact: Pam Jones, LPI Program Services Department, 3303 NASA Road 1, Houston, TX 77058. Phone: 713-486-2150.

## December

- 3-7 **American Geophysical Union, Fall Meeting**, San Francisco, California. Contact: AGU, 2000 Florida Avenue NW, Washington, DC 20009. Phone: 202-462-6900.

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