COMET HALLEY AND XVII LPSC

The SEVENTEENTH LUNAR AND PLANETARY SCIENCE CONFERENCE will be held at the Johnson Space Center, Houston, TX, March 17-21, 1986, under the sponsorship of the Lunar and Planetary Institute, NASA-Johnson Space Center, the American Geophysical Union, the Division for Planetary Sciences of the American Astronomical Society the Geological Society of America, International Union of Geological Sciences, and the Meteoritical Society. Chairmen of the Conference are Dr. Michael Duke, JSC, and Dr. Kevin Burke, LPI.

The Lunar and Planetary Science Conference is recognized as the leading international conference for the presentation of new results in planetary science, bringing together a group of specialists in petrology, geochemistry, geophysics, geology and astronomy. Scientists in all lunar and planetary programs are invited to submit abstracts and to participate in the conference.

The conference will open with registration and a social at the Lunar and Planetary Institute on Sunday evening, March 16th. Light refreshments will be served from 7:00 p.m. until 10:00 p.m. Conference participants are encouraged to come and mingle with old friends, register, and receive abstract volumes, packets and badges. The Galveston Limousine vans will provide shuttle service between LPI and the local hotels during these hours.

Pre-registration: Sending in your registration prior to your arrival really cuts down on the time spent waiting in registration lines. The fee for conference participation is $35 for all attendees except students with student ID's, who may register for $20.00. Pre-registration will be accepted through March 10.

Program: There will be no more than three concurrent sessions. Nine half-days will be devoted to presentations of research papers in topical symposia and in problem-oriented sessions. A topical session entitled "Martian Geomorphology and Its Relation to Subsurface Volatiles" will be held as part of this year's Conference. (For additional information on this session, see separate article elsewhere in this issue.) Another session, probably an evening general session, will be on the many "Recent Encounters" by various space probes.

Special Sessions: Some evenings will be set aside for special sessions. These sessions may be impromptu or may be devised and structured by members of the Lunar and Planetary Science community as desired. These sessions will not be considered part of the formal program. A special session already scheduled will be held on Monday evening in the Berkner Room of the LPI. Chaired by Dr. John Krimighe, it will be an informal discussion to discuss the book and conference project on "Meteorites and the Early Solar System." (For additional information, see separate article elsewhere in this issue.)

Poster Sessions: Poster sessions are becoming more and more popular at the conference and will be available as an alternative to oral presentations. Requests for display space must be supported by informative abstracts. The program committee will employ the same criteria to govern allocation of space in poster sessions as for oral presentations.

Abstracts: Abstracts are to be short papers that can be cited in the literature. Abstracts will be limited to two pages. For readers of the BULLETIN who did not receive the first announcement for the conference and wish to submit an abstract, please contact the Projects Office for abstract forms and additional information. (713-486-2150)

The Deadline for receipt of abstracts at the LPI is 10 January 1986. Abstracts arriving after January 10 will be subject to a $20 late fee, per abstract. Late abstracts should be accompanied by check, cash, or completed purchase order. Authors outside the United States may pay late fees at conference registration, and should include a letter with their abstract stating such intent. Abstracts arriving the day of the Program Committee meeting will not under any circumstances be published in the abstract volume, but they may be considered for oral presentation at the conference. Any abstracts arriving after the Program Committee meeting will be returned to the author. Abstracts of papers submitted to the conference will be published in Lunar and Planetary Science XVII.

Abstract volumes will be available to registrants at the Conference. Copies of the Abstracts remaining after the conference will be available for a small handling charge plus postage. Watch the February BULLETIN for order form and price list.

Chili Cook-off: The Sixth Annual LPSC Chili Cook-off/Barbeque Dinner will be held on Tuesday, March 18. The cook-
off portion of the social will be held only if at least 15 teams enter. Planning is also underway for team participation in a variety of simple contests apropos to the cook-off theme. Forms for entering chili cook-off and/or contest teams are in the second mailing for the Conference. If you do not get this mailing or need more forms or have any questions, call the Projects Office (713-486-2150). The more teams, the more fun.

The following schedule lists dates important to the submission of abstracts, to attendance at the conference, and to the submission of papers for the Proceedings.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
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<tbody>
<tr>
<td>January 10, 1986</td>
<td>Deadline for submission of abstracts</td>
</tr>
<tr>
<td>January 24, 1986</td>
<td>Program committee meeting</td>
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<tr>
<td>March 17-21, 1986</td>
<td>Seventeenth Lunar and Planetary Science Conference</td>
</tr>
<tr>
<td>May 1, 1986</td>
<td>Deadline for submission of papers to the XVIIth Proceedings</td>
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The February issue of this BULLETIN will contain the preliminary program for the conference and ordering information for Lunar and Planetary Science XVII.

SPECIAL MEETINGS TO BE HELD AT XVIIth LPSC

**Special Mars Session Planned for LPSC XVII:**

*Martian Geomorphology and its Relation to Subsurface Volatiles*

A special MECA session entitled *Martian Geomorphology and its Relation to Subsurface Volatiles* will be held as part of the 17th Lunar and Planetary Science Conference. The format of the special session will include both contributed talks and a panel discussion/debate. Among the questions that will be addressed are: What evidence supports the identification of various martian landforms as reliable indicators of subsurface volatiles? If such indicators do in fact exist, what can they tell us about the state and distribution of subsurface volatiles? Are the inferences made from one morphologic indicator consistent with those inferred from another? Finally, what additional analyses or experiments should be conducted, either now or as part of some future mission, to resolve the remaining uncertainties regarding the state, distribution, and total inventory of subsurface volatiles on Mars? Individuals whose research bears on these questions are strongly encouraged to submit an abstract for consideration in the program.

Questions regarding the special session should be directed to the session organizers: Stephen Clifford (713-486-2146) and Lisa Rossbacher (714-598-4809). —(SC)

**Meteorites and the Early Solar System**

An informal meeting will be held in the Berkner Room at the LPI on Monday, March 17 at 8:00 p.m. in connection with the book and conference being planned by the University of Arizona.

The conference is being planned for January 6-9, 1987 in Tucson, Arizona. The book will be similar in format to other books in the Space Science Series of the University of Arizona Press.

The purpose of the meeting at the Lunar and Planetary Science Conference will be to provide a progress report on the project and to listen to suggestions from members of the community. The meeting will be open to anyone interested in the topic of *Meteorites and the early solar system* and Dr. John Kerridge, who is coordinating this project, assures us "that the meeting will end at a reasonable hour to permit St. Patrick's Day observance." For more information, contact Dr. Kerridge, Institute of Geophysics, UCLA, Los Angeles, CA 90024. Telephone: 213/825-3331.

**LUNAR AND PLANETARY SCIENCE CONFERENCE “FORUM”**

During the 15th Lunar and Planetary Science Conference, a meeting was organized by a group of participants who were concerned about the organization of the LPSC. Several issues and possible solutions were discussed during that meeting. The consensus was that steps should be taken to provide a mechanism for airing opinions, problems and needs concerning the annual conference and publications relating to it.

The group voted to initiate an annual Lunar and Planetary Science Conference "Forum." to be held during the conference each year, where meeting participants could openly express and discuss mutual concerns. This year the forum will be held on Thursday, March 20.

Suggestions for issues to be placed before the Forum are hereby solicited. The questions, comments, and suggestions which you send in will be summarized and distributed to all Lunar and Planetary Science Conference attendees at registration. The summary will serve as the basis for the Forum agenda.

Please send all comments to the LPI Projects Office, 3303 NASA Road 1, Houston, TX 77058.

**ALL YE AUTHORS, PLEASE NOTE — PUBLISHERS’ EXHIBIT**

The Library Information Center (LIC) at the LPI will again sponsor a Combined Publishers’ Exhibit at the XVIIth Conference. We do query a number of publishers to submit items for the exhibit, BUT if you have a new book coming out, and would like to have a copy on display, or brochures describing it, be sure to either alert your publisher to send a display copy to Fran Waranius, at the LPI, or send one yourself. If you will send it or give us information about the publication before the conference, we will be able to include the information in our catalog of the exhibit. Deadline for materials to be included in the catalog is February 28, 1986.
PROGRESS IN THE LUNAR INITIATIVE

Over the past four years, a few scientists in the Johnson Space Center's Solar System Exploration Division have been advocating various research and technology thrusts which would address issues associated with the establishment of a manned lunar surface base following the low Earth orbit Space Station. As more people have recognized that space transportation technology will be in place before the end of the century to accomplish this project, discussion groups and study efforts have sprung up around the country. Many of the activities are being coordinated out of JSC/SSED and are loosely referred to as the Lunar Initiative in the absence of an official NASA lunar base program. The following is an update on the progress of the advocacy.

**Lunar Bases and Space Activities of the 21st Century**

In April, 1984, a workshop with about 50 attendees was convened in Los Alamos to discuss the potential uses of the Moon, the technical feasibility of a permanent facility, and the societal implications of lunar occupation. The Report of the Lunar Base Working Group served as a structure for the program of a public symposium, held at the National Academy of Sciences in Washington, DC, during the last week of October, 1984. Approximately 300 attendees heard 135 papers on a broad spectrum of social, scientific, and technological topics. Keynote speakers included George Keyworth, James Beggs, Harrison Schmitt, Edward Teller, Walter Hickel, and Arthur Kantrowitz. The breadth of discussion at the symposium will be reflected in a forthcoming collection of over 80 short papers, entitled *Lunar Bases and Space Activities of the 21st Century*. The book will be going to press in the next few weeks and will be available from the LPI early next year. A pre-publication offer for this book is published elsewhere in this *BULLETIN*. A second symposium is planned for the spring of 1987; a first call for papers will appear in the next few months.

Other symposia are being planned, often in conjunction with meetings of professional societies. A set of papers discussing *Science on the Moon* will be given in a special session at the Aerospace Sciences Meeting of the American Institute of Astronautics and Aeronautics in Reno, Nevada, January 6-9, 1986. Dr. Richard Vondrak of Lockheed Missiles & Space Co. is the organizer.

A special session on *Astronomy from the Moon* is being planned for the American Astronomical Society meeting which will be held in Houston, Texas in January 1986. Among the expected topics of discussion will be radio, IR, and optical interferometry on the lunar surface; very large aperture telescopes; high energy photon and cosmic ray detectors; SETI; costs of a lunar base; and impacts on ground-based astronomy. Dr. Jack Burns, University of New Mexico is coordinating this workshop.

The American Society of Civil Engineers has formed a task committee on extraterrestrial resource development which is planning a session on lunar civil engineering at a future meeting. Dr. Ray Leonard of Zia Corp. chairs the committee.

Dr. Wendell Mendell of NASA/JSC has been invited to speak on the importance of lunar surface agriculture at the opening of an international conference of horticulturists, held quadrennially. Over 4000 attendees from 90 countries are expected to attend the nine day meeting at the University of California, Davis, in August, 1986. A special symposium on horticulture in exotic environments will address problems to be faced on the Moon and Mars.

Very preliminary planning has begun for an international conference on electromagnetic transportation technology in the lunar context, to be sponsored by the American Mag-Lev Corporation in Atlantic City, NJ, in September, 1986. It is anticipated that the conference will attract participation from NASA, Dept. of Transportation, Ministries of Science and Technology in Europe and Japan, and representatives of private industry. Major themes will be lunar surface infrastructure, advanced transportation technology, and private sector participation in space development.

Drs. Grant Heiken and David Vaniman of the Los Alamos National Laboratory have received NASA support for the production of a *Lunar Resources Handbook*. The editors have received commitments from 20 scientists and engineers with lunar expertise to summarize 15 years of lunar research in a form useful to scientists, engineers, planners, managers, and students who will be implementing human presence on the Moon. They anticipate a book of about 500 pages costing less than $40 and are looking for a company to publish and market it.

**National Commission on Space**

The Presidential Commission, empaneled to examine long range goals in national space policy, has been holding hearings throughout the country. During a visit to the Johnson Space Center, they heard Dr. Mike Duke speak on the status of lunar base planning and Dr. Larry Haskin discuss the potential of lunar and asteroidal materials in space applications. The Commission also has heard testimony on manned Mars missions from parties both inside and outside NASA. The members are very interested in the nature of the infrastructure required to accelerate space development. A manned lunar base is a key enabling element in many scenarios involving large scale space activities.
**NASA-BOM Cooperative Agreement** NASA and the Bureau of Mines have signed a memorandum of understanding to define the research and development areas of mutual interest and to provide opportunity for cooperative programs in space exploration and establishing permanent lunar bases. Although no transfer of funds is involved, the agreement does provide an administrative mechanism whereby researchers in the two agencies can work on projects of mutual interest. During the Apollo program, the BOM produced a body of research on terrestrial analogs of lunar materials and studied concepts for lunar mining and civil engineering.

**Earth-Moon Depot** Studies of the economics of lunar operations and the utilization of lunar resources reveal the importance of the space transportation infrastructure. Obviously, lowering the Earth-to-orbit launch cost is an important objective; but the roles of other, more subtle characteristics of space transportation are being appreciated. For example, the low Earth orbit (LEO) space station is universally assumed to be the principal node for the transshipment of terrestrial payloads to all destinations in space. In particular, current concepts of manned Mars missions depict the trans-Mars spacecraft as being assembled in LEO. Recent NASA studies calculate that such a vehicle will be larger than the LEO space station, will take a year to construct, and must be prepared to launch in a window a week or so wide which opens every two years. For a minimum fuel design which uses aerobrakes both at Mars and upon return to Earth, an equivalent of 18 Shuttle flights are required just for propellant delivery!

NASA’s plans for lunar operations similarly have included a low lunar orbit space station as a transportation node. Fifteen years ago Bob Farquhar of NASA/GSFC argued that certain advantages accrued to the placement of a station at the Earth-Moon Lagrange point, L2, on the far side of the Moon. The five Lagrange, or libration, points are “nulls” in the combined fields of two gravitationally bound bodies. A small body placed exactly at a Lagrange point will “feel” no attraction to either body in the absence of external perturbations to the system. In the Earth-Moon case, the L2 point is unstable; and a free body will gradually drift into the clutches of one of the two planets. Conversely, very small delta v’s (propulsive maneuvers) are sufficient to send a spacecraft to either destination.

A satellite or a space station can be placed in a “halo orbit” about this theoretical point in space. A halo orbit requires propellant for occasional trim maneuvers, but the usage is very small. Low lunar orbits also require trimming due to lumps in the lunar gravitational field caused by subsurface mass concentrations (mascons). The total energy (or delta v) required to transfer from LEO to the lunar surface via L2 is essentially the same as a transfer via lunar orbit. However, the far Lagrange point always lies on the Earth-Moon line and thus approximately maintains a constant selenographic location, analogous to the behavior of geosynchronous satellites relative to geographic locations. As a consequence, transfers can be made to any point on the lunar surface without waiting for alignment of the orbital plane of a lunar space station. Halo orbits about L2 or L1 (the point between the Earth and the Moon) are ideal for communication satellites servicing lunar surface operations.

The preceding discussion can be viewed as an attempt to answer the question, “Where is the best transportation node, beyond LEO, for support of lunar operations?” After realizing the logistical complexity of launching a manned Mars mission from LEO, Paul Keaton of the Los Alamos National Laboratory formulated the more general question, “Is there a preferred location for a depot which supports launches to all destinations beyond LEO?” In his recent publication, *A Moon Base/Mars Base Transportation Depot* (LANL Report LA-10552-MS), he proposes that “[t]he ideal location . . . would be a spot that can be reached from LEO with no more than escape velocity, that requires no fuel to stay there, and that has an infinite launch window. Also, it would be easy to coast near the Earth [either to pick up a gravitational assist to a deep space destination or to aerobrake in the atmosphere for LEO transfer]. An added bonus would be obtained if the spot had velocity relative to the Moon so that lunar gravitational assists could be used . . .”
Keaton then presents an analysis of orbital transfers between Lagrange points and various destinations in space. Using only simple approximations, he derives delta v's with quite reasonable accuracy, which demonstrate that the L1 point of the Sun-Earth system satisfies almost all these criteria. The second best location is the L2 point of the Earth-Moon system, discussed above. A fascinating confirmation of the major points of the analysis occurred recently when the ISEE spacecraft was sent from its halo orbit about the Sun-Earth L1 point to intercept the comet Giacobini-Zinner, using only small hydrazine thrusters and ingeniously designed gravitational assists from the Earth and the Moon.

**PLANET EARTH STUDIES**

Enthusiasm for looking at the Earth as a planet is widespread at this time. Dr. Burton Edelson, NASA Associate Administrator in an editorial in *Science*, January 25, 1985 and in an address to the Global Habitability seminar at the 36th Congress of the International Astronautical Federation in Stockholm, called on the worldwide scientific community to accelerate its study of planet Earth.

Calling for an international study effort, Edelson said, "Our sophisticated spacecraft, new air, sea and space-borne sensors, and enormous computing capability will enable us to measure, monitor, model and finally begin to understand the Earth as a system. This mission to planet Earth could unlock the secrets of life itself. Mysteries that have puzzled great natural philosophers for centuries are at our fingertips and waiting to be solved, thanks to modern science and space technology. This quest for knowledge may well prove to be the most important ever undertaken by humankind. For what could be more important than the preservation of planet Earth?"

Emphasizing the importance of his proposal, Edelson said, "The U.S. National Academy of Sciences has reviewed the scientific merit of the global habitability concept and has found it to be both sound and worthy. The Academy is now participating in the broader efforts of the International Council of Scientific Unions in a program called Global Change. NASA and several other government agencies, notably the National Oceanic and Atmospheric Administration and the National Science Foundation, also will participate."

In keeping with this concept, the Planetary Geology Division, Geological Society of America (GSA) and the Lunar and Planetary Institute will co-sponsor the first of a series of workshops to be held each year during the weekend before the annual meeting of the GSA. *The Earth as a Planet Workshop* is planned for Sunday, October 27, 1985, preceding this year's annual meeting in Orlando. Dr. Donald Anderson, California Institute of Technology and Dr. Kevin Burke, Lunar and Planetary Institute are organizing the workshop. Four sessions on the general themes: Mega-geomorphology; the Mantle; the Early Earth; and, new methods of remote sensing of the Earth and planets will structure the program.

Many NASA planning scenarios assume that a mannable platform in geosynchronous orbit (GEO) is the next step into space beyond the LEO space station. Keaton's analysis demonstrates that GEO is absolutely the worst location for a transportation depot, from the point of view of orbital mechanics. It is clear that the nature of the space transportation infrastructure of the future can be correctly discerned only when planners consider the entire panoply of space activities of the 21st Century.

Inquiries concerning the Lunar Initiative should be directed to W. Mendell or M. B. Duke, Mail Code SN, NASA/JSC, Houston, TX 77058.

**Goddard Scholarship Announced**

The National Space Club will award a $7,500 scholarship for the academic year 1986-1987. The scholarship is in memory of Dr. Robert H. Goddard, America's rocket pioneer. The award is given to stimulate the interest of talented students in the opportunity to advance scientific knowledge through space research and exploration. The 1986 Award Winner will be introduced to the nation's leaders in science, government and industry at the Goddard Memorial Dinner to be held March 21, 1986.

Deadline for application is January 17, 1986. Additional information can be obtained from:

National Space Club/Goddard Scholarship
655 15th Street, N.W., Suite 300
Washington, DC 20005
Telephone: 202/639-4210

Mr. Stephen E. Dwornik is the Chairman of the Scholarship Committee.

**A Reminder to Non-U.S. Citizens**

**Planning to Visit the Johnson Space Center**

Non-U.S. citizens who wish to visit laboratories at the NASA Johnson Space Center are reminded that certain actions are required well in advance of the planned visit. NASA rules and procedures require that non-U.S. citizens wishing to make an official visit to JSC (or any other NASA center) should contact their embassy in Washington D.C. and ask the embassy to request authorization for the visit from the International Affairs Division at NASA Headquarters. The visitor should give the dates of the planned visit, names of the NASA persons to be visited, and the purpose of the visit. NASA approval of the visit should be obtained before arriving at JSC. Under some circumstances, this procedure can be shortened if the visitor is a student or faculty member at a U.S. university. This procedure does not apply to attendance at scientific sessions at the Lunar and Planetary Science Conference held at JSC, but does apply to visits to the analytical and curation laboratories at JSC.
WORKSHOP ON GREENSTONE BELTS

A Workshop on the Tectonic Evolution of Greenstone Belts will be held at the Lunar and Planetary Institute on January 16-18, 1986. This workshop is part of the Early Crustal Genesis Project.

The workshop will be organized within the framework of five discussion topics, each incorporating a wide range of Earth-science subjects including sedimentology, structure, stratigraphy, igneous and metamorphic petrology, isotope geology, geochronology, mineralization, etc. The preliminary sessions identified by the organizing committee are:

I. Greenstone belts: their rock components and structures
II. Greenstone belts: their rock sources and provenances
III. Greenstone belts: their externalities (exogenous variables such as heat flow fluids and strain, specifically with respect to metamorphism-metasomatism)
IV. Greenstone belts: their boundaries, their surrounding rock terrains and their interrelationships

WATER MAY HAVE PLAYED MAJOR ROLE ON MARS

Ice, snow, flowing rivers and vast lakes may have played a major role in shaping the ancient Martian surface and climate, a panel of scientists reported today at NASA's Ames Research Center, Mountain View, Calif.

Their scientific presentation grew out of research discussed at the "Water on Mars Workshop," which brought 83 scientists to Ames last winter and included more recent work in this active field.

Early in the planet's history, according to Bruce Jakosky of the University of Colorado, Boulder, the Martian poles were tilted more directly toward the sun than they are today. As a result, the polar ice caps may have sublimed (changed directly from a solid to a gaseous state) into the atmosphere during the continual daylight of polar summer.

Vapor from the caps would have been carried by Martian winds to the equatorial regions. At equatorial latitudes, where night always alternates with day, the chill of nightfall would have precipitated water vapor as snow, Jakosky said.

Gary Clow of the U.S. Geological Survey, Menlo Park, Calif., reported that an equatorial snowpack could have been heated by sunlight trapped inside the snow fields. A reflective, insulating blanket of snow can trap sunlight, much as a greenhouse holds the sun's warmth. Thus, even if the surface of Mars had still been cold, melting beneath an insulating snowpack could have let water escape to carve the "valley network" channels of Mars. These valley network channels as well as larger outflow channels—both strongly resembling dry riverbeds on Earth—were photographed by Mariner 9 in 1972.

The larger outflow channels are thought to have been created by sudden release of enormous amounts of subsurface water, which may have dug the channels in a matter of weeks.

The valley network channels, which Clow has studied, are smaller and indicate the existence of a more moderate climate on early Mars, allowing liquid water to flow for long periods of time.

Huge ice-covered lakes also may have existed on the ancient Martian surface in the immense Valles Marineris canyon system, according to Steven Squyres of Ames. Viking photographs of the floor of these canyons, Squyres said, reveal thin, flat-lying layers of sediments which appear to have been laid down in standing bodies of water.

Today, Mars is so cold that all water on its surface freezes. Although the Martian atmosphere is 95 percent carbon dioxide (an effective infrared absorber), it is so thin that it cannot trap the heat of the sun.

Dry ice (solid carbon dioxide) covers the polar regions of Mars. Water-ice lies underneath the northern cap and perhaps under the southern polar cap as well. The water-ice at the northern pole is revealed when the overlying dry ice vaporizes each summer.

Water-ice in the Martian polar caps does not melt because temperatures rarely climb above freezing, except at the equator. It sublimes directly into the atmosphere, forming wispy clouds on Mars. Earth's billowy clouds are formed by tiny droplets of liquid water.

Today, ice is present in the Martian ground in regions above 30 degrees latitude, according to Squyres and Michael Carr of the U.S. Geological Survey. Examining Viking photographs of impact craters, Squyres and Carr found evidence of "terrain softening"—a rounding off of features indicating water activity beneath the surface. Terrain softening of smaller, more recent craters suggests that ice remains present in these northern and southern regions. Like the tundra of Alaska, this deeply-frozen ground never thaws.

The presence of ice indicates that liquid water exists deep within the planet, according to Carr. Half a mile beneath the
surface, water in the pores of Martian rocks is liquid, Carr says. It is heated by the high temperatures present at these depths in the Martian crust.

Robert Haberle of Ames, studying water distribution on Mars using data gathered by Viking orbiters, has found that water lost by the north polar cap during summer is not fully recovered in the winter. He wants to determine where this water goes.

Movement of water and carbon dioxide to and from the polar ice caps and movement into and out of the rubbly Martian ground may be responsible for the mysterious "layered terrains" that fringe the polar caps.

In winter, carbon dioxide condenses over the polar region, depositing a layer of mingled ice and dust. This layer then becomes cemented into place by water-ice and remains when the carbon dioxide evaporates again in the spring. Periodic changes in the Martian climate, caused by fluctuations in the planet's tilt toward the sun, can alter the amount of gas which condenses, thus creating layers of varied sizes.

According to James Pollack of Ames, the Martian climate in the past may have been warmer and wetter. An earlier atmosphere may have been much thicker with more carbon dioxide available to hold the sun's warmth. Rivers and lakes of liquid water could have dotted the ancient landscape.

This earlier, warmer climate actually may have destroyed itself, Pollack says. The presence of liquid water would have accelerated weathering of rocks, enhancing chemical reactions that take carbon dioxide out of the atmosphere and incorporate it into minerals. With the loss of carbon dioxide from its atmosphere, heat would have escaped the planet's surface, cooling the planet and locking up its water as ice.

However, not all scientists accept this theory on how Mars lost its originally-thick atmosphere. A new theory, suggested at the workshop by Peter Schultz of Brown University, is that the cataclysmic impact, that created the immense Argyre basin on Mars, may have perturbed its climate by blowing into space a significant part of the atmosphere. Schultz noted that Martian terrains, formed after the Argyre impact, have fewer dry channels than older terrain, a feature that suggests a major climatic change at that time.

Besides Earth, Mars is the only planet in our solar system that experiences cyclical changes in climate. Understanding past and present conditions on Mars will help scientists decipher Earth's climate, said Haberle.

NOTE: Workshop on Water on Mars Report of the workshop held at NASA/Ames Research Center, November 30-December 1, 1984, Lunar and Planetary Institute Technical Report 85-03, is available from the Library Information Center at the LPI. This 105-page report is distributed to requestors in the United States for $3.00 prepaid. Foreign orders are $7.75 U.S. for air mail delivery; $4.00 surface mail.

Another related report Workshop on Dust on Mars held at Arizona State University, Tempe, Arizona, February 4-5, 1985 has been published as LPI Technical Report 85-02. This 26-page report is $3.00 for U.S. orders and $5.50 for foreign orders sent air mail; $3.00 for foreign orders sent surface mail.

An order form for these reports is included in this issue of the Bulletin.

Airline plans comet flight (AP)

British Airways is offering a sky-high seat for the great Halley's Comet show.

For the equivalent of $42, the state-owned airline is promising to take passengers on a hour-long trip over the ocean at 35,000 feet on a moonless night—well above most atmospheric pollution and away from the glare of city lights. The flights, in December and January, will operate from Manchester Airport.

The airline says the windows of the 99-seater BAC-111 aircraft to be used for its flights will be "as clean as possible."

TOPOICAL CONFERENCE ABSTRACT

Volume available

LPI Contribution 575 contains abstracts of the papers presented to the Heat and Detachment in Crustal Extension on Continents and Planets topical conference which was held in Sedona, Arizona on October 10-12, 1985.

The abstract volume is available from the Library Information Center at the LPI for the cost of postage and handling. Please see order form in the BULLETIN for cost and ordering information.

EDUCATIONAL PLANS FOR SHUTTLE MISSION 51-L ANNOUNCED

Live lessons to classrooms around the country and scientific demonstrations filmed for use in educational products are just some of the activities that will be involved with Shuttle Mission 51-L and the flight of the first Space Flight Participant.

Christa McAuliffe, the finalist in the NASA Teacher in Space Project, along with Barbara Morgan, the back-up candidate, reported to NASA's Johnson Space Center, Houston, on Sept. 9 to begin training which will continue until the flight of 51-L now set for launch no earlier than Jan. 22, 1986.

NASA is making plans for a direct satellite broadcast and schools will be able to observe lessons from space. The first live lesson entitled The Ultimate Field Trip will allow students to compare daily life on the Shuttle with that on Earth. McAuliffe will take viewers on a tour of the Shuttle, explaining crewmembers' roles, showing the location of computers and controls and explaining experiments being conducted on the mission. She also will demonstrate how daily life in space is different from that on Earth in the preparation of food, movement, exercise, personal hygiene, sleep and the use of leisure time.
The second lesson called *Where We've Been, Where We're Going* will help the audience understand why people use and explore space by demonstrating the advantages of manufacturing in the micro-gravity environment, highlighting technological advances that evolve from the space program and projecting the future of humans in space.

Also during the 51-L mission, McAuliffe will be involved in several activities which will be filmed and later used in educational products. Potential activities include:

- **Earth Magnetism**—Photograph and observe the lines of magnetic force in three dimensions in a microgravity environment.
- **Newton's Law**—Demonstrate Newton's first, second and third laws in microgravity.
- **Bubbles**—Understand why products may or may not effervesce in a microgravity environment.
- **Space Expressions**—Generate from students creative works that reflect their interpretation of the space program/experience.
- **Simple Machines/Tools**—Understand the use of simple machines/tools and the similarities and differences between their uses in space and on Earth.
- **Hydroponics in Microgravity**—Show the effect of microgravity on plant growth, growth of plants without soil (hydroponics) and capillary action.
- **Chromatographic Separation of Pigments**—Demonstrate chromatography in a microgravity environment and show capillary action (the mechanism by which plants transport water and nutrients).

The educational emphasis on Shuttle Mission 51-L will be further enhanced with a program now in its 6th year at NASA. Three Shuttle Student Involvement Project experiments will fly onboard the Shuttle and McAuliffe will assist the mission specialists in conducting them. The experiments deal with using a semi-permeable membrane to direct crystal growth, studying chicken embryo development in space, and the effect of weightlessness on grain formation and strength in metals.

NASA PRESS RELEASE NO. 85-139, 10-3-85

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NEW PUBLICATIONS

Some of the following publications are available from the Superintendent of Documents, Government Printing Office, Washington DC 20402. Although this agency requires prepayment on all orders, they will accept Mastercard or VISA credit cards. Just include the account number and expiration date on your order to them. Some of the publications may be available from the GPO bookstores which are found in major cities around the U.S. Check your city directory for a local listing.

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**NASA PUBLICATIONS**

*Far Travelers: The Exploring Machines*  
This is a story told by a man who was there of the successes and failures, the great scientific achievements and engineering developments that were the result of the unmanned lunar and planetary probe missions of NASA. It covers the era from early development in the late 1950's to the Pioneer program in the late 70's.

In the words of the author, "It is not a history... It is not a scientific report," although one finds much history and several discussions of the technical aspects of the missions in the book. The book is highly readable and would certainly be of interest to people who find the exploration of the solar system a fascinating topic.

This book can bring one up to date on what went before the Vikings and Voyagers. It certainly does bring back some memories almost but not quite forgotten.

The only fault is that there is no index, not even a name list which could have helped make this a more useful book as a reference tool.

This 256-page volume by Oran W. Nicks is NASA Special Publication (SP) 480. It is available from the Government Printing Office as S/N 033-000-00957-7 $17.00 U.S. $21.25 Foreign.

**Catalog of Apollo 15 Rocks**  
The "Catalog of Apollo 15 Rocks" by Graham Ryder, Lunar and Planetary Institute, Northrup Services, Inc., is scheduled for distribution in mid-October, 1985. The 1300-page, 3-part publication contains information on 267 Apollo 15 rocks and is similar in format to the Catalog of Apollo 16 Rocks by Ryder and Norman. Copies may be obtained from Dr. D. P. Blanchard, Lunar Sample Curator, Mail Code SN, Johnson Space Center, Houston, Texas 77058. This catalog is Curatorial Branch Publication 72 and Johnson Space Center document JSC 20787.
OTHER PUBLICATIONS AND MATERIALS OF NOTE

Slide Set on Comets and Comet Halley
A new collection of slides about comets in general and the upcoming return of Halley’s Comet in particular is now available from the Astronomical Society of the Pacific. Compiled by Dr. John C. Brandt, (NASA Goddard Space Flight Center), a noted expert on comets, the set is accompanied by a 16-page booklet with detailed captions, nontechnical introductory material on comets, and a bibliography.

Among the 31 views included in the set are the recovery photo of Comet Halley (taken at Palomar in 1982) photos and diagrams of the six spacecraft being sent to comets in 1985-86, color and black-and-white images of several of the most dramatic comets of the 20th century, finding charts for Comet Halley’s return and even some sheet music inspired by the last pass of that famous comet.

The set can be obtained for $25.95 (including postage and handling) from:
Astronomical Society of the Pacific
Comet Slides Dept.
1290 24th Avenue
San Francisco CA 94122

Return of the Comet
The subtitle of this book is almost as important as the opening title: An Activity Book for Skywatchers from 9-14 with Adult Teaching Guide. This activity book is available from the Pacific Science Center, Seattle, Washington. It is a unique combination of timely information and challenging activities. Readers of this fun and educational book:

- Make a Halley’s Comet Calendar for their wall to track the comet as it makes its once-in-a-lifetime visit near the Earth.
- Use a flip book to discover how comets move through space.
- Make a model comet to understand the immensity of the comet’s tail.
- Use observation charts to track and observe the comet as it approaches Earth.

Included is a teaching guide for parents, teachers and youth group leaders to help children and adults discover comets together.

Mail orders for this well-illustrated, attractive 40-page book can be sent to the Arches Gift Shop at the Pacific Science Center, 200 Second Avenue North, Seattle WA 98109. Individual copies are $7.95 plus $1.00 for postage and handling. Quantity discounts are available.

Space Bibliographies Available
The National Space Institute has prepared a series of annotated bibliographies on 20 space and astronomy topics. These bibliographies are valuable for anyone involved in scholastic or research endeavors, or anyone simply interested in being aware of the resources available. The listings describe references, mostly at the introductory level, available in book and magazine form, and include a brief description of the content. The bibliographies are free to NSI members who will supply a stamped, addressed envelope to NSI. Non-members may obtain copies for $2.50 per bibliography. Topics include:
No. 1 History of Astronautics; No. 2 Rockets; No. 3 Celestial Mechanics; No. 4 Black Holes; No. 5 Space Astronomy; No. 6 Solar Power Satellites; No. 7 Space Stations; No. 8 Space Law and Treaties; No. 9 Navigation in Space; No. 10 Space Manufacturing; No. 11 Space Colonies; No. 12 NASA History, Structure and Operations; No. 13 Space Medicine; No. 14 Planets; No. 15 The Sun; No. 16 Remote Sensing Satellites; No. 17 Communications Satellites; No. 18 Military Operations in Space; No. 19 Space Shuttle System; No. 20 Extraterrestrial Resources.

Send order with appropriate check or supply your NSA membership number, indicate by number the ones you would like to have and send your request to: NSI Bibliographies, 600 Maryland Avenue SW, Room 203W, Washington DC 20024

Universe, and Universe in the Classroom
Universe by William J. Kaufmann III is a new text book designed to meet the needs of instructors of either a one- or two-term course at the under-graduate level. The book’s 29 chapters are easily divided into two nearly equal parts, the first half dealing with early models of the universe and planetary astronomy and the second half treating stars, galaxies, and cosmology.

Distinguishing features of this text include ample use of colored illustrations, highlighting of important facts through the use of “boxes,” essays from six renowned astronomers, summaries, study questions, and additional readings. The book is published by W.H. Freeman, New York, for $32.95.

An interesting companion to the textbook is Universe in the Classroom by Andrew Fraknoi. Mr. Fraknoi who is executive director of the Astronomical Society of the Pacific has put together a resource book in astronomy that is designed for use with Dr. Kaufmann’s book but which would be useful to any astronomy instructor. The comments on resources, films, slide sets, additional readings for student and teacher, sample exam questions, laboratory exercises, and topics for discussions and papers provide materials that constitute a cross between a lesson plan and a curriculum guide. Also published by W.H. Freeman, Mr. Fraknoi’s book is available for $8.95.

The Third Experiment: Is there Life on Mars?
This book addresses the question of extraterrestrial life on the planet Mars based on three of the experiments carried on the Viking Landers. Dr. David E. Fisher first outlines the history of Earthly thoughts and dreams about Mars and Martians, and why life there is of particular interest. Then he discusses the possible definitions of a living being and goes on to describe many of the experiments conceived to test for
life. The book is written for a junior high school audience but in some instances the author makes aside references that I am not sure the average 11 to 13 year old would understand. I am not sure that they would know who Agatha Christie was. The chapters in which Dr. Fisher simplifies the organic chemistry involved in the living organism is very readable and understandable.

The book is published by Atheneum. 115 Fifth Avenue, New York City 10003 for $12.95 and should be available through any good book store. It is not to be considered "light" reading but should be an interesting book to young persons (and conceivably their older siblings and parents).

Union List of Astronomy Serials

This publication compiled by Judith A. Lola, librarian at Yerkes Observatory, is a compilation of the astronomy holdings of 14 astronomy libraries including U.S. Naval Observatory, Kitt Peak National Observatory, and Yerkes Observatory. Over 1800 titles are included in this list which makes it an excellent bibliographical tool for astronomers as well as librarians.

The list is a project of the Physics-Astronomy-Mathematics Division of Special Libraries Association and is priced at $20.00 prepaid (Please add $5.00 if billing is required.) Checks should be made payable to PAM DIVISION, SPECIAL LIBRARIES ASSOCIATION and orders sent to:

Judith A. Lola
Yerkes Observatory Library
PO. Box 258
Williams Bay WI 53191

Memorial Reprint Available

A reprint of the Thomas McGetchin obituary written by Robin Brett is available from the Geological Society of America, 3300 Penrose Place, Boulder CO 80301.

Shuttle Views the Earth: Geology from Space

The Planetary Image Center at the LPI announces the availability of an LPI Geological Slide Set compiled by Peter Francis and Pat Jones. The set includes photographs of stunning geological features on the Earth's surface which capture the attention of Shuttle astronauts, mission after mission. The pictures taken from orbit allow us to appreciate the beauty of large structures, such as meteor impact craters which can be observed in their entirety and in the context of their surroundings. It is possible to compare old volcanic features with young erupting volcanoes at various locations around the world. Viewed from space, deserts are both foreboding and beautiful. Shuttle photographs reveal just how much of the Earth's surface is covered by vast deserts. They also illustrate the arid beauty of sand dune formations.

The 40-slide set comes complete with an explanatory booklet containing descriptions of the features shown on each slide and is available for $15.00 U.S. Please add $5.00 for overseas postage. An order form is included in this BULLETIN.

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If you want to be sure that you get all of your mailings from the Institute promptly, be sure to send a change of address to: Mailist, Lunar & Planetary Institute, 3303 NASA Road One, Houston, TX 77058-4399. It often takes the postal service 60-90 days to return an item to us with the address correction. Do yourself and us a service. Remember the LPI Mailing List when you move. Thanks.

—ye editor

The LUNAR AND PLANETARY INFORMATION BULLETIN is published by the Lunar and Planetary Institute. There are usually three issues per year. It is distributed free on request to lunar and planetary scientists, educators, students, and their institutions.

The next issue will be in FEBRUARY. Copy deadline is JANUARY 20, 1986. If you have any announcements which you would like to have printed in the BULLETIN, please send them to the Editor.

Editor: Frances B. Waranius
Lunar and Planetary Institute
3303 NASA Road One
Houston, TX 77058-4399
Phone: 713/486-2135
###calendar

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
<th>Location</th>
<th>Organizer/Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>November 13-15</strong></td>
<td></td>
<td></td>
<td><strong>Workshop on Apollo 15</strong>&lt;br&gt; Lunar and Planetary Institute, Houston, Texas</td>
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<tr>
<td><strong>December 6-7</strong></td>
<td></td>
<td></td>
<td><strong>Workshop on Europa</strong>&lt;br&gt; Moffett Field, California</td>
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<tr>
<td><strong>December 9-13</strong></td>
<td></td>
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<td><strong>American Geophysical Union—Fall Meeting</strong>&lt;br&gt; San Francisco, California</td>
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<tr>
<td><strong>January 5-9</strong></td>
<td></td>
<td></td>
<td><strong>American Astronomical Society</strong>&lt;br&gt; 167th Meeting Houston, Texas</td>
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<td><strong>January 10</strong></td>
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<td></td>
<td><strong>Astronomical Observations from a Lunar Base</strong>&lt;br&gt; Houston, Texas</td>
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<td><strong>January 16-18</strong></td>
<td></td>
<td></td>
<td><strong>Workshop on the Tectonic Evolution of Greenstone Belts</strong>&lt;br&gt; LPI, Houston, Texas (See information elsewhere this LPIB)</td>
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<tr>
<td><strong>January 24</strong></td>
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<td><strong>URANUS FLYBY BY VOYAGER 2</strong></td>
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<tr>
<td><strong>February 1-9</strong></td>
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<td><strong>International Volcanological Congress</strong>&lt;br&gt; Auckland-Hamilton-Rotorua, New Zealand</td>
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**1986**

- **January 5-9**: American Astronomical Society<br> 167th Meeting Houston, Texas<br> Organizer: Robert Haymes<br> Space Physics and Astronomy Dept.<br> Rice University<br> P.O. Box 1892<br> Houston TX 77251<br> Phone: 713-527-4056
- **January 10**: Astronomical Observations from a Lunar Base, Houston, Texas<br> Organizer: Jack O. Burns<br> Physics and Astronomy Dept.<br> University of New Mexico<br> 800 Yale Blvd. N.E.<br> Albuquerque NM 87131<br> Phone: 502-277-2705
- **January 16-18**: Workshop on the Tectonic Evolution of Greenstone Belts, LPI, Houston, Texas (See information elsewhere this LPIB)<br> Organizer: Pam Jones<br> Lunar and Planetary Institute<br> 3303 NASA Road One<br> Houston TX 77058-4399<br> Phone: 713-486-2150
- **January 24**: URANUS FLYBY BY VOYAGER 2
- **February 1-9**: International Volcanological Congress<br> Auckland-Hamilton-Rotorua, New Zealand<br> Organizer: Dr. J. A. Gamble<br> Dept. of Geology<br> Victoria University of Wellington<br> Private Bag<br> Wellington New Zealand.
February 10-13  **Space Adaptation Symposium**, 7th International Man in Space Symposium, Houston, Texas.


**MARCH 17-21**  **17TH LUNAR AND PLANETARY SCIENCE CONFERENCE,** Houston, Texas

May 19-23  **American Geophysical Union, Spring Meeting**, Baltimore, Maryland.

June 1-6  **Third International Conference on Geoscience Information**, Adelaide, South Australia.

June 22-26  **168th Meeting of the American Astronomical Society**, Ames, Iowa

June 30-July 4  **Sixth International Conference on Geochronology, Cosmochronology and Isotope Geology**, Cambridge, England.


August 6-8  **Mercury Conference**, Tucson, Arizona

Martin Prinz  
Dept. of Mineral Sciences  
American Museum of Natural History  
New York NY 10024  
Phone: 212-873-1300

October 14-18  **International Symposium: Origin and Evolution of Planetary and Satellite Systems**, Potsdam, DDR.

Prof. Dr. H. Stiller  
Zentralinstitut fur Astrophysik  
Potsdam, DDR


Dr. R. Reinhard  
Space Science Dept.  
ESA, ESTEC  
Postbus 299  
2200 AG Noordwijk, The Netherlands.

December 8-12  **American Geophysical Union** Fall meeting, San Francisco, California.

American Geophysical Union  
2000 Florida Avenue NW  
Washington Dc 20009  
Phone: 202-462-6903

December 15-19  **Space Exploitation and Utilization**, Sheraton Waikiki Hotel, Honolulu, Hawaii.

American Astronautical Society  
6212-B Old Keene Mill Court  
Springfield VA 22152  
Phone: 703-866-0020

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MUNSTIER, 4400 MUNSTEII, FRG): HICIIH SIKELSS 
SHALLOW MUONHUAIKS: EVIDENCE FOR AN INITIALLY 
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SPACE UTILIZATION, COLONIZATION, ETC.


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ASTEROIDS


LPIB No. 42

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Meteoricites (Continued)


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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comet Halley &amp; XVIIth LPSC</td>
<td>1</td>
</tr>
<tr>
<td>Special Meetings at XVIIth LPSC</td>
<td>2</td>
</tr>
<tr>
<td>LPSC &quot;Forum&quot;</td>
<td>2</td>
</tr>
<tr>
<td>Publishers' Exhibit - Authors Note</td>
<td>2</td>
</tr>
<tr>
<td>Progress in the Lunar Initiative by W. Mendell</td>
<td>3</td>
</tr>
<tr>
<td>Planet Earth Studies</td>
<td>5</td>
</tr>
<tr>
<td>Goddard Scholarship Announced</td>
<td>5</td>
</tr>
<tr>
<td>Note to U.S. Citizens Visiting NASA</td>
<td>5</td>
</tr>
<tr>
<td>Workshop on Greenstone Belts</td>
<td>6</td>
</tr>
<tr>
<td>Water on Mars</td>
<td>6</td>
</tr>
<tr>
<td>Airline Plans Comet Flight in England</td>
<td>7</td>
</tr>
<tr>
<td>Heat &amp; Detachment Conference Abstract Volume</td>
<td>7</td>
</tr>
<tr>
<td>Educational Plans for Shuttle 51-L</td>
<td>7</td>
</tr>
<tr>
<td>New Publications</td>
<td>8</td>
</tr>
<tr>
<td>Calendar</td>
<td>11</td>
</tr>
<tr>
<td>Bibliography</td>
<td>15</td>
</tr>
<tr>
<td>ORDER FORMS</td>
<td></td>
</tr>
<tr>
<td>Shuttle Views the Earth Slide Set</td>
<td>13</td>
</tr>
<tr>
<td>Lunar Bases and Space Activities - Pre-Publication Offer</td>
<td>29</td>
</tr>
<tr>
<td>New LPI Technical Reports and Contributions</td>
<td>31</td>
</tr>
</tbody>
</table>

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