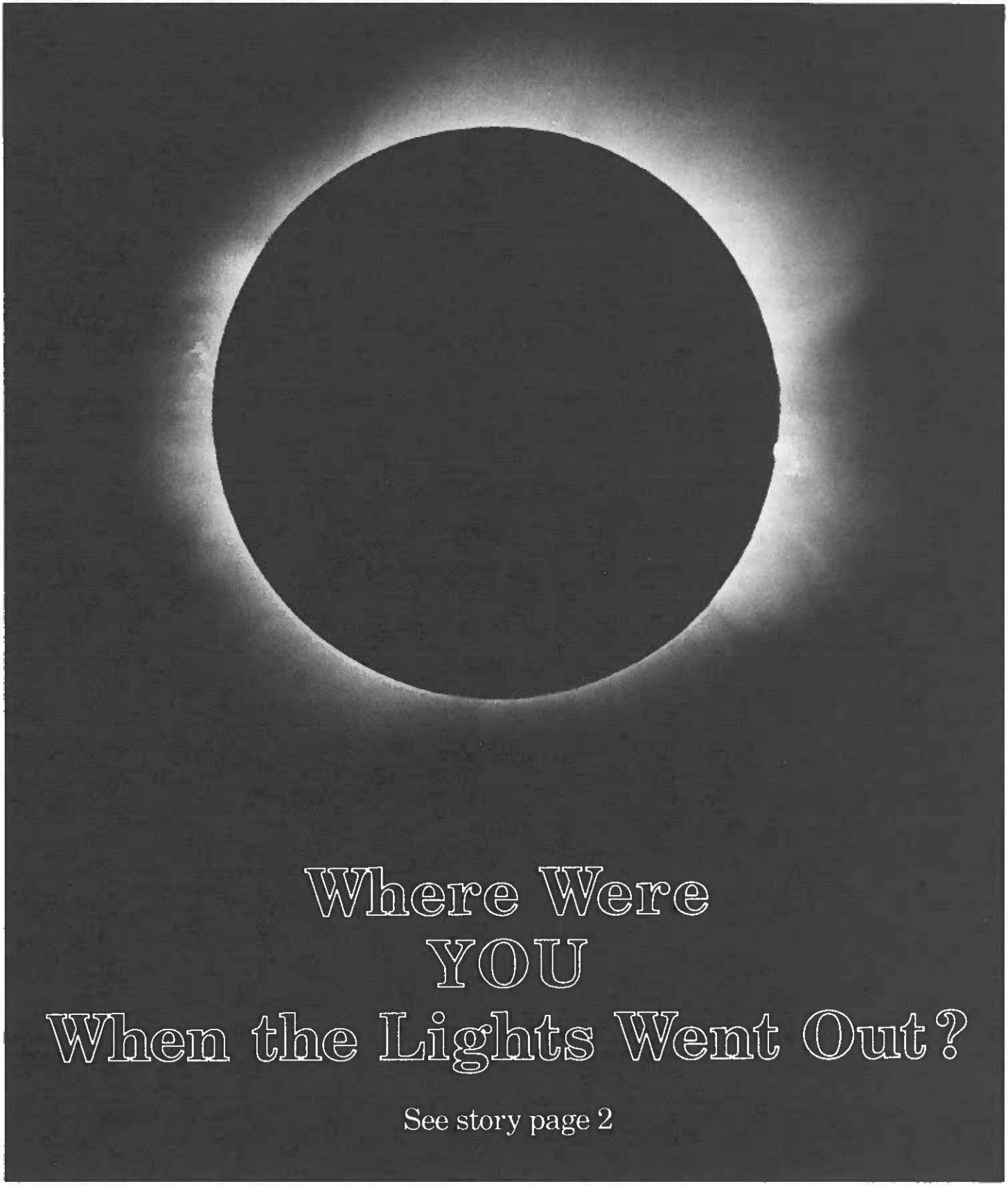
Lunar and Planetary Information
BULLETIN
AUGUST 1991/NUMBER 60 • LUNAR AND PLANETARY INSTITUTE • UNIVERSITIES SPACE RESEARCH ASSOCIATION



Where Were YOU When the Lights Went Out?

See story page 2

Where Were YOU When the Lights Went Out?

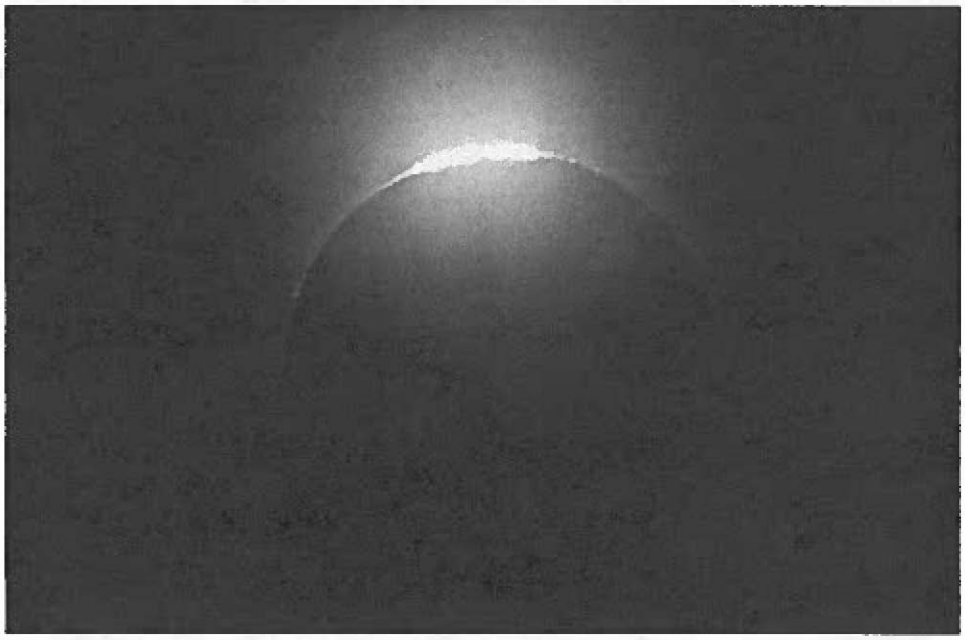
July 11 brought one of the most awe-inspiring astronomical events available to the residents of planet Earth: a total eclipse of the sun. This particular eclipse attracted considerable attention because it was the last total solar eclipse visible from the U.S. in this century. Add to this the fact that the entire Big Island of Hawaii was the piece of American real estate in the path of totality and you have a natural attention-getter. Consequently, the Big Island was invaded by hoards of telescope-toting, camera-laden amateur astronomers, all hoping to capture the ultimate eclipse photo or video. Nature had an interesting way of reminding all of us how little control we can exert on natural phenomena. I was fortunate enough to be one of the witnesses to this natural object lesson.

The morning of July 11 found me on the Waikaloa coast of the Big Island, along with thousands of other observers who believed in "seasonal averages" for cloud conditions. Several groups worked for *years* to secure hotel rooms at this location because of the better than 90% probability for good weather during the eclipse. Unfortunately, July 11 dawned with low clouds hugging the flanks of the surrounding volcanoes. Thirty minutes before totality the partially eclipsed sun rose above the clouds, to the ecstatic cheers of viewers all along the beach. Five minutes later, the expanding cloud bank hid the sun once again; it was not to be seen clearly again until about ten minutes past totality. Naturally, the disappointment was easily seen in many faces. However, some very amazing things were visible beneath the clouds while in the shadow of the Moon.

Clouds along the Waikaloa coast were thin enough to allow brief glimpses of the partially eclipsed photosphere right *through* the clouds. The most memorable glimpse was immediately prior to totality, when a thin "smiling face" appeared. During the seconds leading up to totality this crescent steadily shrank, giving a visible measure of the timescale for the relative motions involved in the eclipse geometry. My sight was fixed on the shrinking crescent but during the final second my peripheral vision detected a wave of darkness speeding across the clouds. The wave caught up to the crescent just as it disappeared at the onset of totality. I believe I caught a fleeting glimpse of the immense, speeding shadow of the Moon.

Totality was surprisingly dark. The light level was probably similar to that on, appropriately enough, a cloudy night near full Moon. The southern horizon had a faint red glow on the distant clouds outside the shadow. With nothing more to watch after the disappearance of the shrinking crescent, I watched along the western horizon to see the end of totality and gradually the red-lit clouds grew. The end of totality was marked by a surprisingly rapid increase in light level. The surroundings brightened with perceptible speed, attaining sunset levels within tens of seconds, almost as if a giant reostat were restoring the sunlight. In spite of the presence of the clouds, I knew I had been fortunate enough to be in a special place at a special time. — *Jim Zimbelman*

(Dr. Zimbelman is a planetary scientist at the Center for Earth and Planetary Studies/National Air and Space Museum of the Smithsonian Institution, Washington, D.C.) Ø



The "diamond ring" as totality ends, above, and the total eclipse on the cover were photographed by Ed Malewitz from City of Refuge, Honaunau Bay, Hawaii using a Nikon F3-MD-4 through a Takahashi FC-50 telescope (400 mm focal length, f-stop 8.0, on Kodak Ektar 125 film) mounted on a Takahashi Sky Patrol mount.

PHOTO: D. RUEB

At LPI, staff and summer interns used a variety of low-tech instruments to view the 66% partial eclipse visible in the Houston area.

The *Lunar and Planetary Information Bulletin* is published quarterly by the Lunar and Planetary Institute, 3303 NASA Road 1, Houston, TX 77058-4399.

Pam Thompson, Editor

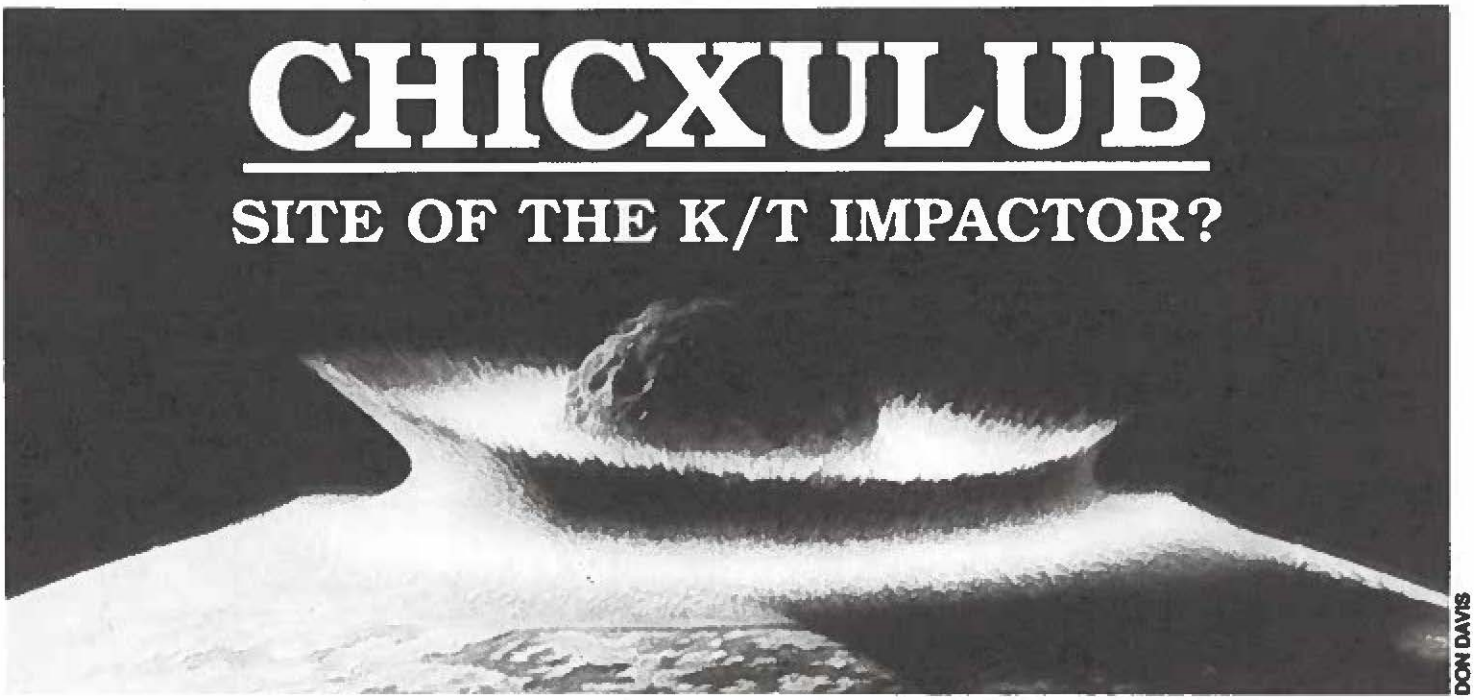
Editorial and production support are provided by the LPI Publications Services Department. Copy deadline for the November issue of the LPIB is October 14, 1991.

Please send articles or announcements to: P. Thompson, 3303 NASA Road 1, Houston TX 77058-4399.

Phone: 713-486-2175, Fax: 713-486-2162
E-Mail: SPAN LPI::THOMPSON

CHICXULUB

SITE OF THE K/T IMPACTOR?



DON DAVIS

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

EVIDENCE OF IMPACT

In addition to the biological evidence, researchers have found geochemical and physical residues that point to impact of an extraterrestrial body 65-68 million years ago. Since its formation, the Earth has differentiated; that is, through global heating, it has formed three layers (core, mantle, crust), each with a distinct general chemistry. Relationships between groups of elements in a rock sample are in effect signatures of the chemistry of the layer in which it formed. Asteroids, however, are undifferentiated, thus the relative abundances of certain groups of elements are quite distinct from those seen on Earth. In particular, the siderophile (iron-loving) elements have migrated preferentially to the (iron) core on Earth and exhibit a profile much different than siderophiles in the most common C1 chondrite class of meteorites.

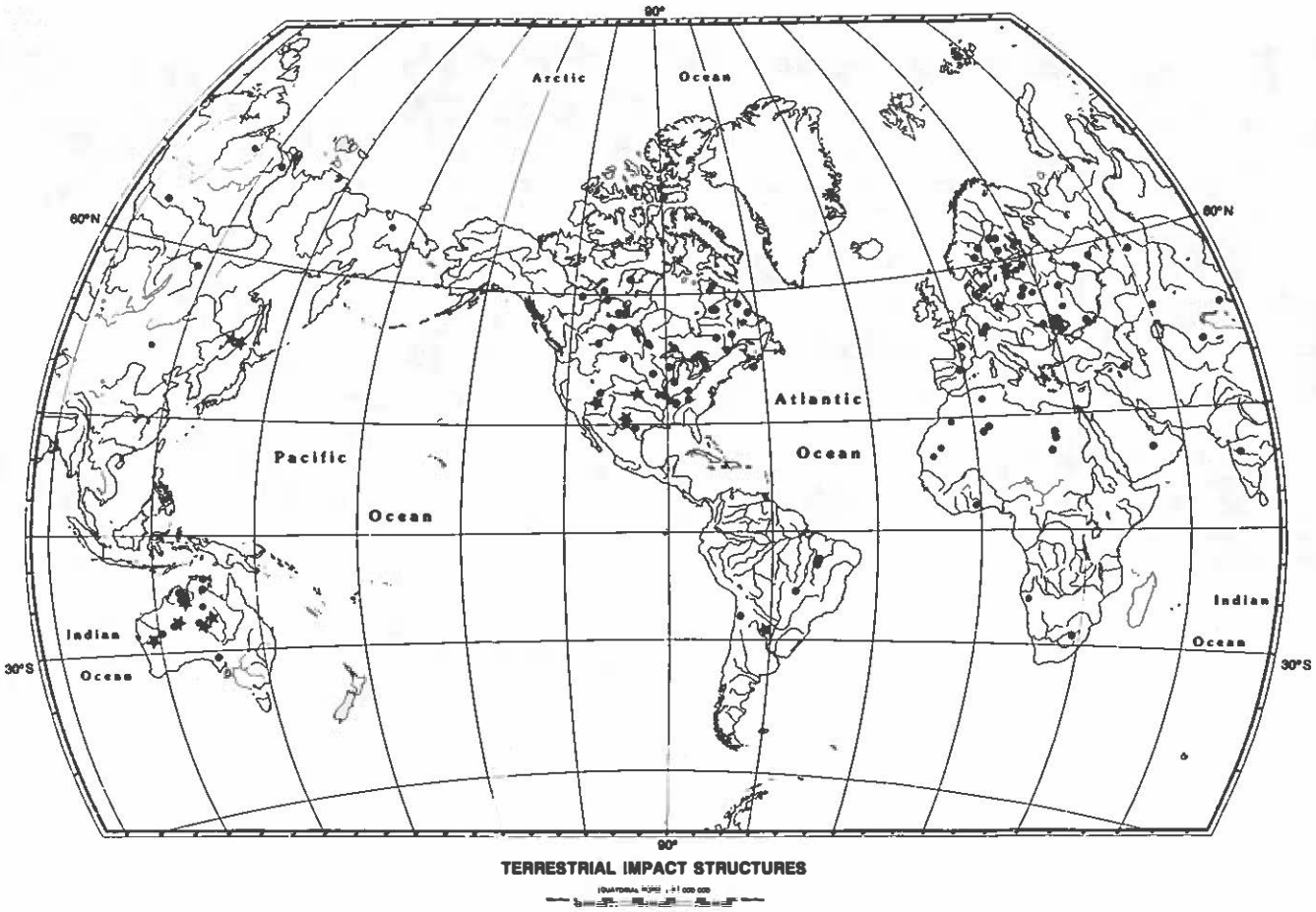
* By convention, the Cretaceous is abbreviated K, because C is used for the earlier Cambrian period.

Of these elements, iridium is the most dramatic marker of an extraterrestrial impact at the K/T* boundary. At more than 100 sites worldwide, researchers have found a layer of clay containing iridium thousands of times more abundant than that normally found in terrestrial strata. By estimating the total amount of iridium that was ejected into the atmosphere by the impact (difficult, because of sampling uncertainties) and comparing that amount with the iridium abundances in C1 chondrites, scientists can make a guess at how large the impactor must have been. Many workers put the size at 5-10 kilometers; the worldwide distribution of iridium fallout also implies an extremely energetic impact.

Additional geological evidence of impact are effects of shock metamorphism, such as the altered appearance of quartz crystals. Parallel striations resulting from shock pressures greater than 100 kilobars are diagnostic for impact origin because no other earthly mechanism produces such pressures. The size distribution of shocked quartz in K/T debris in North America—small to larger from northwest to southeast—suggested that the impact ejecta was splashed across the continent from a site somewhere in Central or South America.

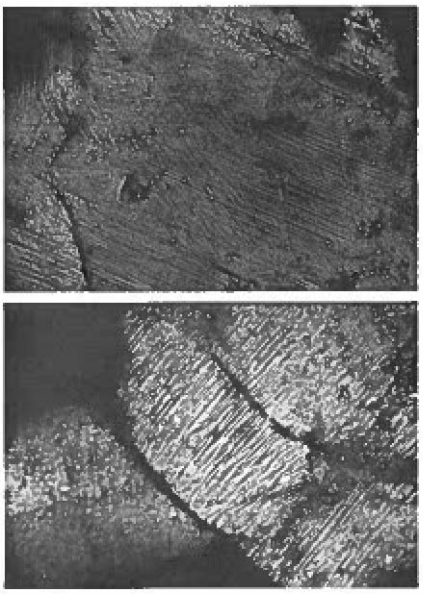
THE SEARCH FOR AN IMPACT STRUCTURE

Although the Earth has been bombarded even more heavily than the Moon in its history, erosion and tectonic activity have erased all but the hundred or so structures worldwide that we see today. Can traces of the impact at the K/T boundary be found? The search for an impact structure of the right age, 65-68 million years old, and the right size, 100-200 kilometers (based on estimates of the size of the impactor), is on. The Manson impact structure, largest in the U.S., is possibly of K/T age but, at 35 kilometers, is probably too small.



Map of known terrestrial impacts. Many have been identified only in the last ten years.

Recent finds have focused attention on the Caribbean and disqualified another candidate. An important discovery is a one-and-a-half-foot layer of altered clays that proved to be weathered tektites in Beloc, Haiti. Tektites are formed when material completely melted by impact is ejected as droplets and shaped aerodynamically into glassy spheres or dumbbells. Analysis of the Beloc tektites revealed that the impact target was not basaltic and thus could not have been in ocean floor, eliminating a 1000-mile depression in the Colombia Basin of the Caribbean Sea as a contender for the source of the tektites (thus, the impact). The chemistry of the tektites, a low-Si, high-Ca yellow glass, suggests a mixture of crustal materials and carbonates, which suggests an impact into continent or continental shelf. Other researchers have found "altered glass" on the Gulf Coast of Mexico that may represent ejecta deposits. Still others have reported what may be wave deposits at different places on the Gulf Coast and as far north as the Brazos River in central Texas, thought to be caused by a tsunami or tsunamis triggered by an impact in the Gulf region.



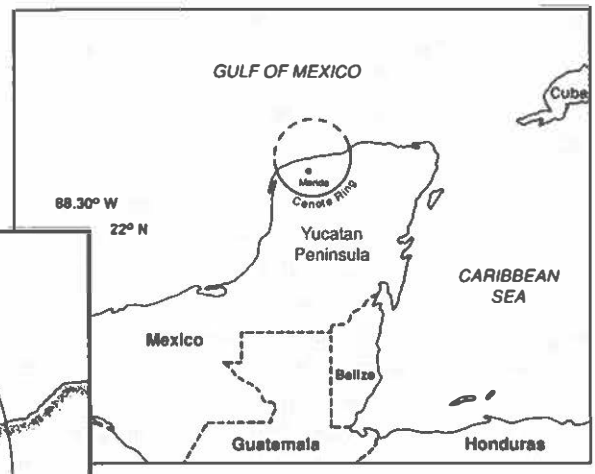
Quartz crystals—(Top) Lamellae (parallel striations) caused by impact shock; (Bottom) lamellae caused by tectonic processes. Distinguishing between these metamorphic features is crucial to identifying impact structures. Shock effects caused by pressures greater than 100 kbar are diagnostic for impact origin.

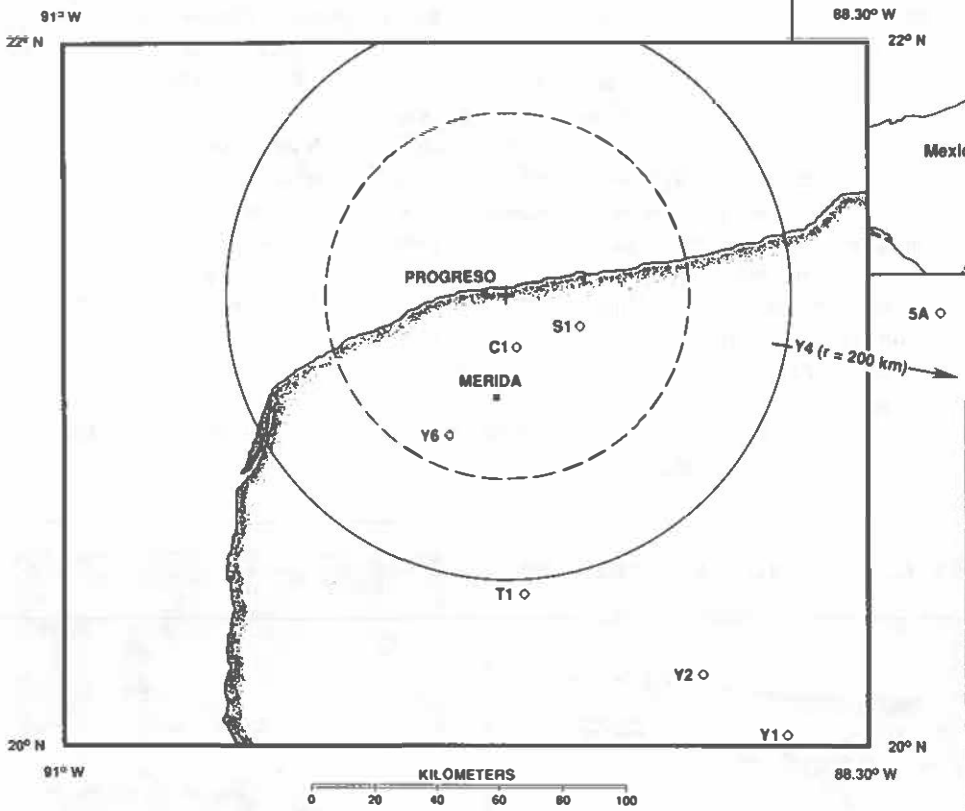
THE CASE FOR CHICXULUB

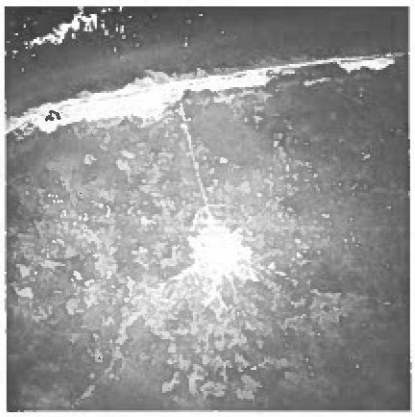
With evidence building for a Central American impact site, researchers looked again at magnetic and gravity data from the area. A semicircular structure around a central gravity and magnetic high appears along the coast of the northern Yucatan near the town of Chicxulub. A carbonate/evaporite platform over andesitic crystalline rocks, the Chicxulub site might be able to produce the interesting chemistry seen in the Beloc samples. The platform itself has been dated Cretaceous at its base through Tertiary at its surface. The impact site, just at the coastline, could also account for the wave deposits around the region, and the structure is possibly 170-180 kilometers across—the right size.

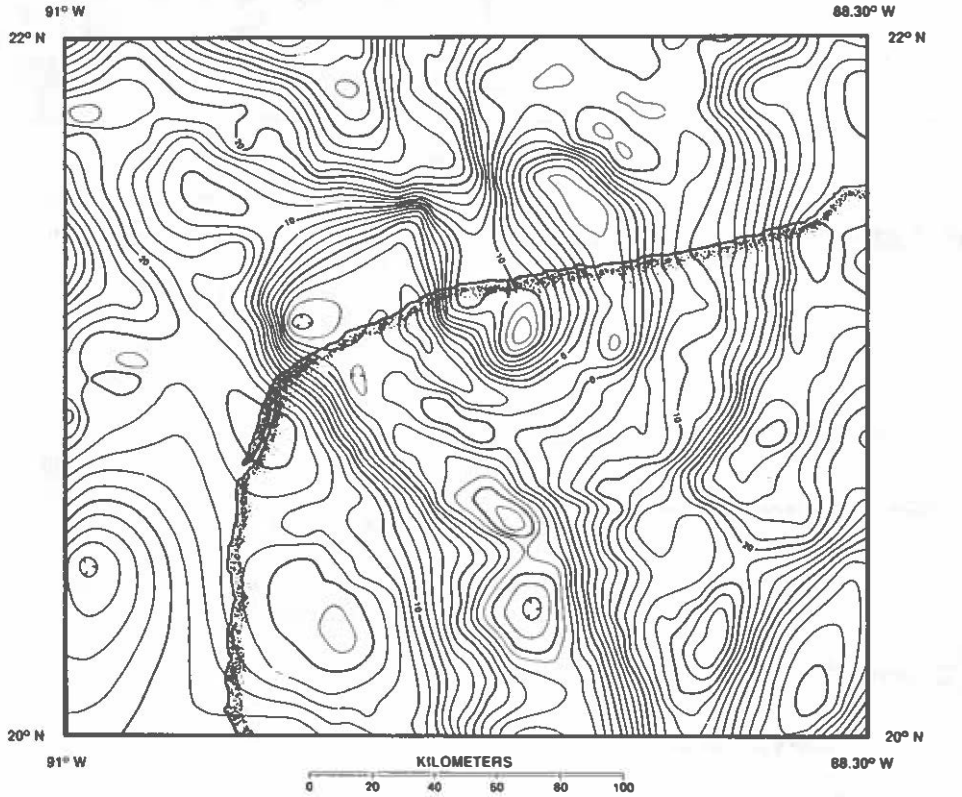
More evidence appeared in recent studies of Landsat images that allowed scientists to plot an apparent semicircle of

The Signature of the K/T Impactor?









In the space shuttle image above, the Yucatan coast looks completely undisturbed. The light circular area in the center is the city of Merida.

Left, a section of the Yucatan coast that may have been hit by a 5- to 10-kilometer meteorite 65 to 68 million years ago. The upper diagram shows the positions of drill holes relative to the position of the proposed structure. Most of the well samples were lost in a fire; data from the few remaining are not yet conclusive. The lower diagram shows gravity measurements of the site. A semicircular (or "y"-shaped) structure can be traced around a central gravity high, proposed to be the impact point (+) of the meteorite. The strong semicircular feature raises the question: Where is the other half of a (likely) circular impact structure?

cenotes, or sinkholes, along the putative "rim" of the structure. If impact origin is correct, they may have formed as crater fill compacted beneath the limestone deposited on top of it, causing cracks that allowed ground water to erode the limestone.

Hopes ran high for a verdict on Chicxulub since Pemex, the Mexican national petroleum company, had drilled wells into the structure years earlier, but the samples had been destroyed in a warehouse fire. Well logs reported brecciated (fragmented) carbonates and evaporites beneath the limestone layer that could represent impact ejecta. Just two samples of the breccia material have been recovered and are being analyzed for evidence of shock effects that will conclusively prove impact origin. Preliminary reports from one lab find shock effects; those from another lab do not.

MORE STUDY NEEDED

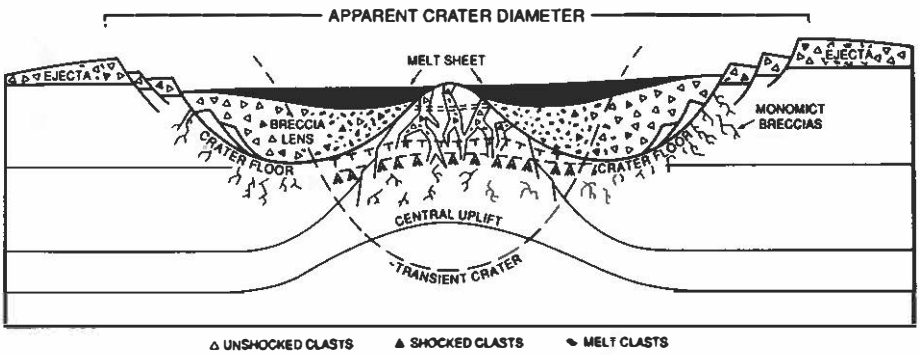
Proof that Chicxulub is the remnant of an event that led to the dinosaurs' demise is not in hand yet. Dr. V. L. Sharpton, of the Lunar and Planetary Institute, suggests that it is possible to read the data we do have in another way. The "ring" structure that many see in the gravity and magnetic data, as well as the presence of cenotes, can also be read as a "y" structure that is seen in rift valley formation. The magnetic and gravity high could result from a buried volcanic center in a rifting environment. As extension occurred outward from the center, thinning and weakening from elastic deformation could result in sinkhole formation.

Another question is whether the Yucatan Platform is too shallow to produce the tsunamis of 1600-3300 feet that have been postulated to account for some of the farther-flung debris deposits. Would it have been completely splashed away?

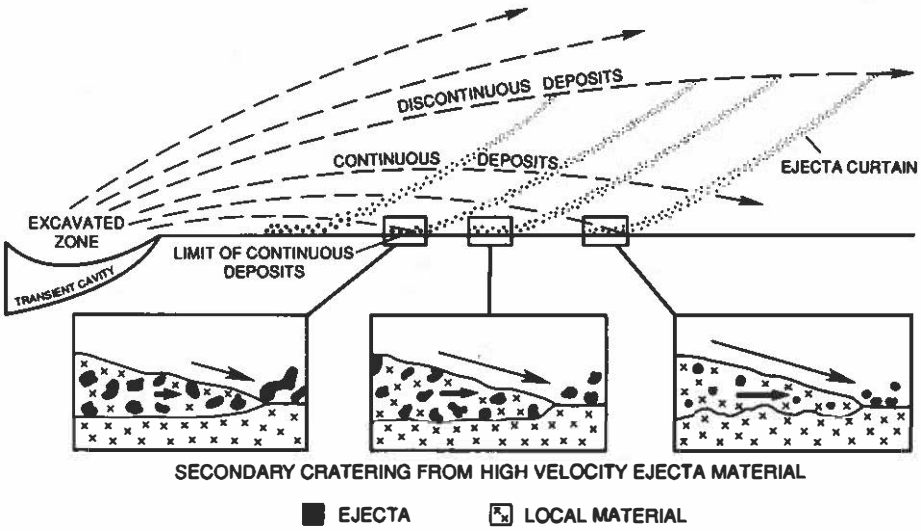
But it is the data we don't have yet that will be decisive. Is the structure an impact crater? Clear evidence of shock metamorphism and iridium enrichment will tell us. The date of the structure is also in question. Pemex samples were dated upper Cretaceous, although many scientists now feel this is too old. Where is the "other half" of this semicircular structure? Although circularity is not diagnostic of impact origin, there must be evidence of some structure off the coast. Can we find the rim?

To answer these questions, a consortium of Mexican, American, and Canadian geologists is forming. Among their first priorities will be a search for extant samples from drill wells and obtaining detailed seismic data from Pemex. ∅

Geologic Cross Section of a Giant Impact Formation



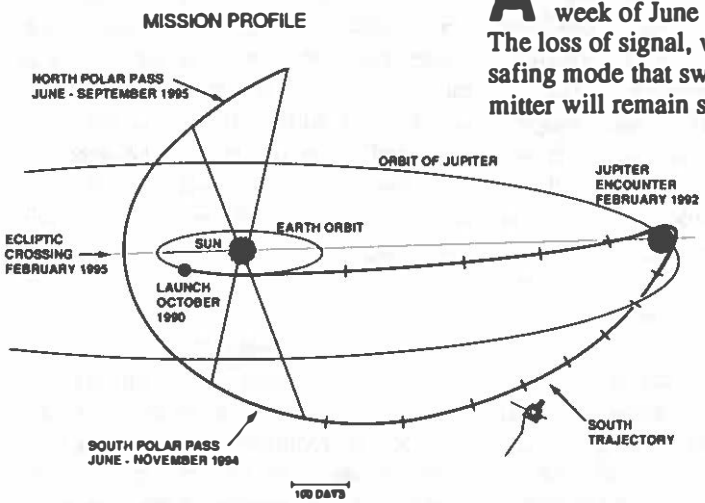
Deposition of Ejecta Material and Secondary Cratering



The lunar impact crater Humboldt, 200 km diameter (above), is about the same size as the proposed impact at Chicxulub but is preserved in the geologically inactive lunar environment. The structure of the crater produced by such a large impact is shown in the top diagram. In addition to shock features, brecciation, and impact melting, the impact generates an extensive ejecta curtain that flies out from the crater itself. Debris from the curtain, such as the tektites found in Beloc, Haiti, eventually falls out to be deposited far from the point of impact (lower diagram).

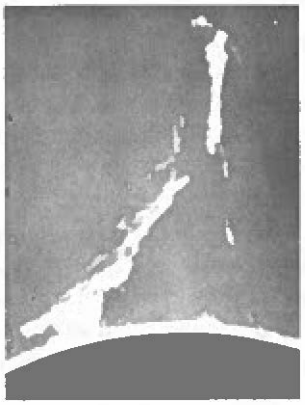
NEWS FROM SPACE

ULYSSES INSTRUMENTS RESTORED TO NORMAL AFTER BRIEF LOSS OF DOWNLINK



All nine of Ulysses' scientific instruments were restored to normal operations the week of June 17 following a two-hour loss of X-band telemetry on June 14. The loss of signal, which remains mysterious, caused the spacecraft to go into a safing mode that switches off the instruments automatically. Ulysses' S-band transmitter will remain switched off while engineers fine-tune the instruments and perform a thorough checkout of the power subsystems to determine the cause of the incident. The S-band had been turned on in mid-May for a six-month solar corona investigation, a radio science experiment to measure the electron content of the Sun's outer atmosphere. The Solar Corona Experiment will resume after the investigation and will include a solar conjunction (where the spacecraft and the Earth are on opposite sides of the Sun). By the end of June, Ulysses was more than 390 million miles from Earth, traveling at a heliocentric velocity of about 45,000 miles per hour toward its February 1992 encounter with Jupiter, where the massive planet will slingshot it out of the plane of the ecliptic into the orbit that will take it over the poles of the Sun.

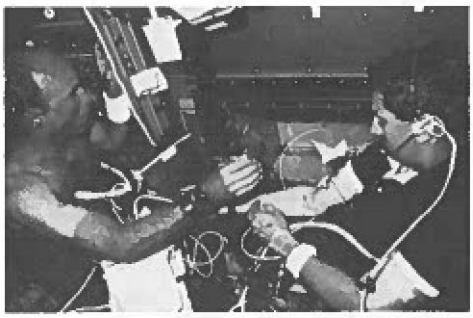
GRO OBSERVES POWERFUL SOLAR FLARES



Two X-class solar flares became the Gamma Ray Observatory's first scientific target of opportunity on Friday, June 7, as the 17-ton craft was rapidly maneuvered into position to observe the sudden event. Solar flares are temporary outbursts of intense radiation that blast hot arching streamers of gas more than 430,000 miles into space. They disrupt the Earth's magnetic field, causing interferences with communications equipment and electric power distribution systems, and they would present a lethal hazard to human space travelers or colonists. Although much is known about the composition and magnitude of solar flares, surprisingly little is known about the thermonuclear processes of these phenomena.

The GRO flight operations team at Goddard Space Flight Center was able to reposition the observatory in only 9 hours instead of the nominal 36, gaining 23 additional hours of observing time, which should give the scientific community confidence in GRO's ability to respond to unpredictable celestial events. With instrument checkout successfully completed, science operation of GRO began on May 16 and a 15-month, full-sky survey by all four on-board instruments will continue.

STS-40: FIRST DEDICATED LIFE SCIENCES MISSION HIGHLY SUCCESSFUL



The Space Shuttle *Columbia* carried aloft the Spacelab module developed for the Spacelab Life Sciences-1 (SLS-1) mission, the first to be dedicated solely to life sciences research. From June 5 through 14 the 7-member crew performed 18 human and 8 animal experiments designed to explore physiological adaptation to the weightless environment. Groups of experiments were designed to examine changes in the cardiovascular, cardiopulmonary, musculoskeletal, renal-endocrine, immunological, and neurovestibular systems. Despite a daunting timeline, crew members were able to gather even more data than planned. Follow-up studies will be conducted on Earth to monitor how microgravity-induced changes in function are reversed upon return to 1*g*.

NEWS FROM SPACE continued page 11

"america at the threshold": the report of the Synthesis Group

Being a highly abbreviated version of the Synthesis Group memoirs of Paul D. Spudis, late of the SG staff.

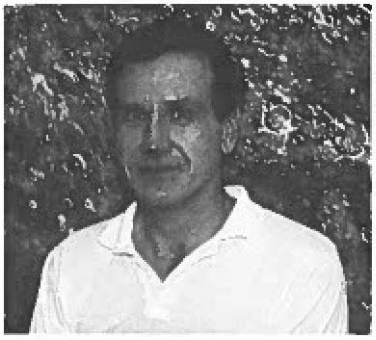
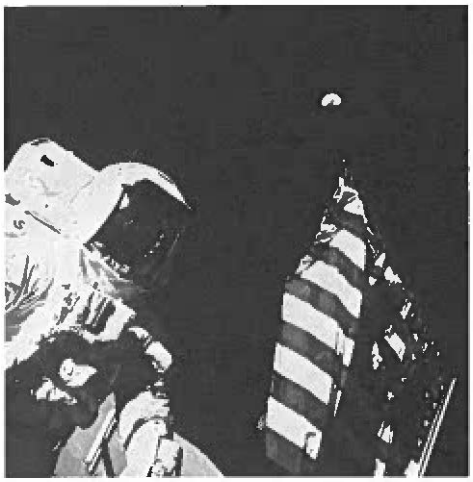


PHOTO: D. RUEB

After President Bush called upon the nation to return to the Moon and send people to Mars (the Space Exploration Initiative, or SEI) over two years ago, a variety of formal and informal study efforts have attempted to understand just what is entailed by such an effort. After the official agency response to the Presidential announcement (the so-called "90-day Study") was unveiled to less-than-universal acclaim, a number of groups have come forth with alternate plans, schemes, architectures, and complaints, all purporting to show how to do the SEI quicker, cheaper, and better. NASA's response to this outpouring of engineering creativity was to establish the Outreach Program (under the auspices of the National Space Council), designed to examine innovative technologies and to recommend at least two alternative architectures for the initiative. Former astronaut Tom Stafford was asked to lead the efforts of an *ad hoc* group, called The Synthesis Group (SG), to evaluate Outreach submissions and produce yet another report on the proper implementation of the Space Exploration Initiative.

Almost a year ago, I was invited to participate in the Synthesis Group. While having some anxiety about putting my research on hold for a year, my concerns were greatly outweighed by my enthusiasm at the occasion to have a positive impact on the Space Exploration Initiative, an effort in which I believe strongly. I have just completed my Washington "tour of duty," and I am now re-encapsulated in the planetary science cocoon whence I came. The report of the Synthesis Group has been issued and I have been asked to write down some of my thoughts on the experience of participating in the group, our recommendations, and the SEI in general.

Americans on the Moon.



NASA PHOTO NO. AS17-134-20384

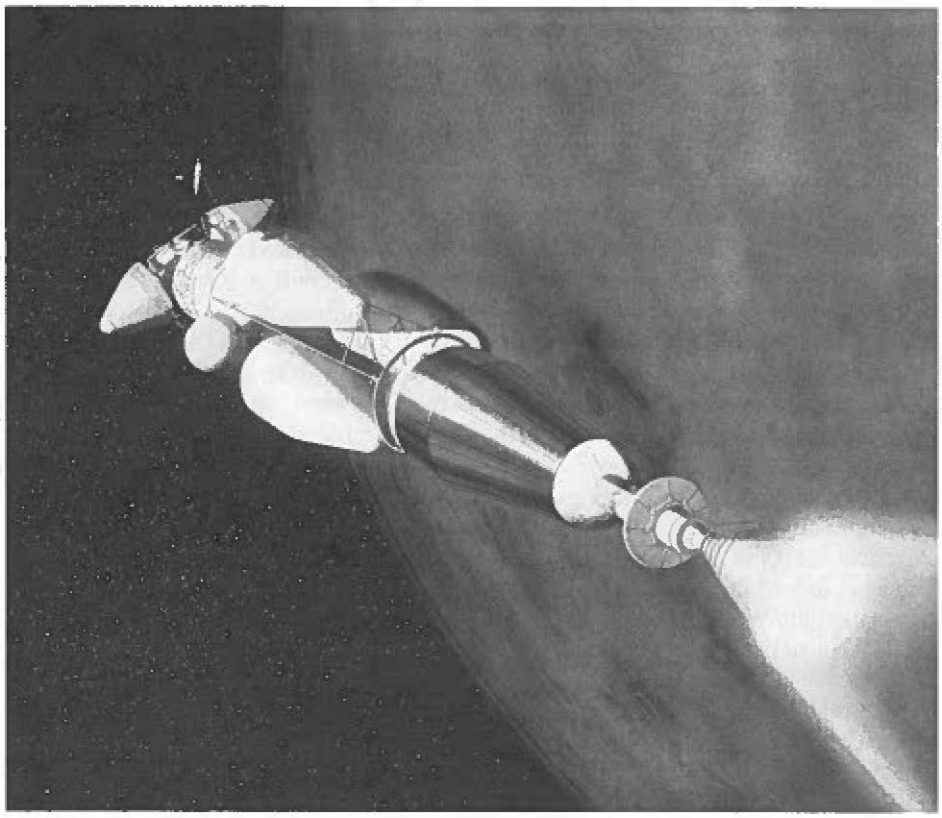
Most of the members of the Synthesis Group were aerospace engineers with a wide variety of experience and backgrounds. Before I arrived in Washington, I was somewhat uneasy about the group's attitude toward science and what role they felt that it should play in the Initiative. Any apprehensions I had were groundless. The members of the Synthesis Group were strongly supportive of science and we all endeavored to insure that science is an integral part of all mission architectures. It was a genuine pleasure to work with such an enthusiastic and dedicated group of people. The year-long assignment was also a crash course for me in a variety of space science and engineering disciplines, including power, propulsion, surface systems, life support, robotics, and many others.

The report of the Synthesis Group, *America at the Threshold,* presents 4 different SEI architectures and identifies 14 key technologies required to successfully complete the Initiative. The architectures vary according to the emphases that they place on three variables: Science and Exploration, Human Presence, and Space Resources. Each variable was used as a primary theme for a particular architecture. For example, the "Moon to Stay" architecture emphasizes surface activities such as closing the life-support loop, manufacturing consumables (e.g., water and air), and building habitats, all these activities being aimed at establishing a permanent human foothold off-planet. Two other architectures likewise emphasize intensive scientific exploration of the Moon and Mars (by both machines and humans) and the exploitation of space resources both for use on the Earth and as a primer for an emerging, space-based economy. Finally, a

"minimalist" architecture was devised to place humans on Mars as soon as possible, similar to the informal "Flags and Footprints" mission architecture, but with a larger component of exploration. Although some architectures are more robust scientifically than others, all feature significant opportunities in all disciplines of the space sciences.

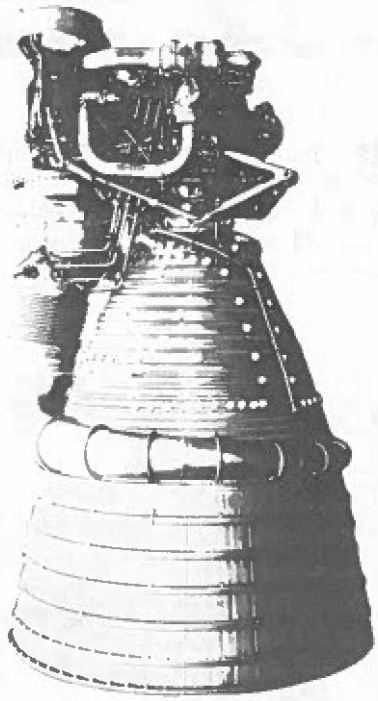
Two of the more notable recommendations of the Synthesis Group are to develop a nuclear thermal rocket engine for the trip to Mars and a new, heavy-lift launch vehicle, possibly based on Saturn technology, to support the Initiative. The advantages of nuclear thermal propulsion are very compelling. In this scheme, liquid hydrogen is fed into a hot, solid-core reactor and expelled as heated exhaust producing thrust; there is no oxidizer and few moving parts. NTR engines produce twice the specific impulse of chemical engines, reducing initial mass in low Earth orbit by at least a factor of two. Use of an NTR can also reduce transit time to Mars to about half of what a chemically based system would deliver. The NTR reactor is launched from Earth cold and does not become radioactive until the Mars Transfer stage leaves Earth orbit. The Synthesis Group believes that use of an NTR engine makes a Mars journey safer and easier.

The SG recommendation to consider using Apollo-Saturn F-1 engines for a new heavy-lift vehicle has also raised a few eyebrows, being called "the last gasp of the Apollo geezers," to paraphrase the *Wall Street Journal*. Although I regret that I cannot lay claim to that honorific, I am particularly proud to say that I was both an instigator and enthusiastic supporter of that particular recommendation. The F-1 engines performed flawlessly on the 13 flights of the Saturn V. Over 50 F-1 engines exist now and can be made flight-ready with little difficulty. The production line for making new engines can be operational within three years; a new heavy-lift rocket based on this technology could be flying within five years (the proposed National Launch System is not scheduled for *test* flights until after the year 2000). A heavy-lift vehicle based on 5 F-1s (Saturn V) can put 150 metric tons in low Earth orbit (LEO), 50% more than the Soviet *Energia*. Moreover, using this vehicle as a core, liquid strap-ons using the F-1 could make a booster with a total capacity of 250 metric tons to LEO. Such a heavy-lift vehicle could put the fully fueled Mars spacecraft into LEO with 3 to 4 launches (compare this with the current estimate of over 20 shuttle flights required to put *Freedom* into LEO).



PAT RAWLINGS, SAIC, FOR OAET/NASA HQ

Nuclear thermal rocket.



The Apollo/Saturn F-1 engine. At 1.5 million pounds of thrust, the F-1 could prove to be the "off-the-shelf" technology capable of making the United States' heavy-lift launch vehicle a reality.

A variety of the Synthesis Group recommendations relate organizational changes and innovations required to successfully undertake and manage the SEI. I'll frankly admit that I don't find this aspect of the report particularly interesting, but I do not question the dire need for a greatly improved way of running our national space program. Is NASA up to the challenge of SEI? Will making the Departments of Energy and Defense partners with NASA in a National Program Office work? One could argue (and many have) that at this stage, anything is worth a try.

But in actual fact, the problem with SEI is not completely with NASA. Questions about what technologies to develop or

a window of opportunity?

by David C. Black

Paul Spudis provides an "up close and personal" perspective on the recently released *America at the Threshold*, the report from the Synthesis Group that was chaired by Tom Stafford. Two questions arise regarding this report: "What is different? Is anything going to happen because of this report?" This is not the first time in recent memory that a colorful report has been released that attempts to chart a course for the future of the civilian space program. There was the report of the Paine Commission, chaired by former NASA Administrator Tom Paine, and the so-called Ride Report, an internal NASA study led by Sally Ride.

It seems to me that several differences exist between the circumstances of the earlier reports and those of the present time. None of the earlier reports enjoyed the level and breadth of support that the current "Mission From Planet Earth," the terminology coined by the Augustine Committee, appears to have. The President is supportive, as is the Vice President and the Budget Director. Indeed the latter is one of the more articulate spokespersons on the Washington scene for the entire space program. In this constellation of key individuals in deciding national programs there is some hope. Also, as recommended in the Synthesis Group Report, the Mission From Planet Earth is viewed as a national effort, one that involves the Departments of Energy and of Defense in addition to NASA. NASA is to maintain the lead role in this proposed coalition. The importance of this recommendation is that it provides a potentially far broader constituency for the program, and it may also serve to energize NASA to assume the leadership role that it is being offered. Failure to do so could mean that one of the other partners in the proposed national program will take the reins. Either way, I believe that the diversity of potential governmental agency involvement will serve as a stimulus to make something happen.

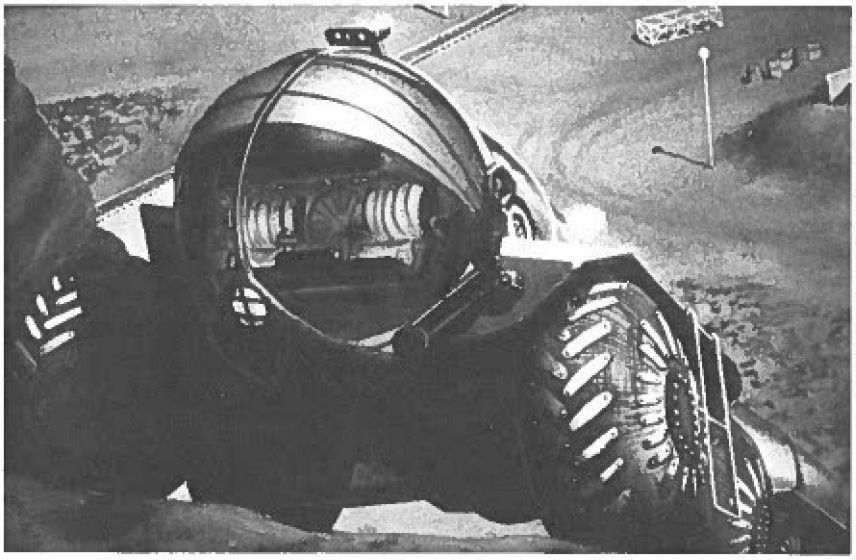
No one can say with any degree of certainty what will actually take place. It is perhaps not unreasonable to guess that if anything of substance is to happen, it will become apparent over the next 12 to 18 months. Budget preparation during that time will be critical, and one could speculate that if nothing is started within that window of opportunity, it is likely that the basic tenets advanced in the Synthesis Group Report will be put on a shelf for a decade or so, at which time they will be rediscovered by "son of Synthesis." A key difference at that time is that there is a real possibility that the American space program will be looking not for a lead role in the exploration of the solar system, but rather for an opportunity to participate as a junior partner with our colleagues from Japan and Europe.

(Dr. Black is the Director of the Lunar and Planetary Institute and was a senior member of the Synthesis Group.)

which architecture makes the most sense are quite irrelevant in the near total absence of a context and reason for undertaking the Initiative. Why should we explore the Moon and Mars? Is there a legitimate reason for humans in space, in any role?

I participated in the Synthesis Group because I believe that we should have a strong and vigorous space program. Moreover, I believe that there are abilities unique to people, and thus humans in space have a critical role to play in our space program. I think that these abilities lie precisely in the realm of exploration (in the broadest sense) and this is, after all, the basic theme of the Space Exploration Initiative. Such activity draws upon the very best that humanity has to offer and serves two fundamental needs: insatiable curiosity (serving emotional needs) coupled with the ability to decipher nature's secrets (serving intellectual needs).

We as a nation have yet to face up to what we want to do in space. An abundance (the more cynical would say overabundance) of studies, reports, and blue-ribbon panels all purport to give guidance and leadership to our space program, but in truth, we have no national consensus on the program, let alone how we should be conducting it. Instead of trying to fit the SEI into some nebulous, "pay-as-you-go," cost-effective Procrustean bed (along with the accompanying sterile "spin-off" analysis), I believe that we should undertake the SEI for a fundamentally simple reason: Human exploration of space excites, inspires, and gratifies the nation. In contrast to most other government programs, which allege to "fix" a problem (nearly always temporarily or incompletely), the Space Exploration Initiative is forward-looking, positive, and an undertaking characteristic of a great power, something the United States professes to be.



PAT RAWLINGS, SAIC, FOR OAET/NASA HQ

Mars rover.

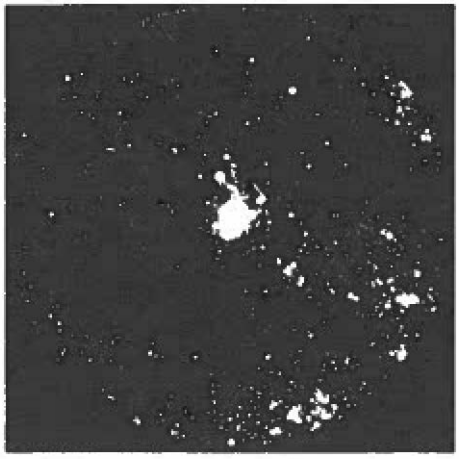
GALILEO ALTERS COURSE FOR GASPRA ENCOUNTER

JPL controllers fired Galileo's onboard thrusters on July 2, slowing it by about 8 miles per hour and adjusting its flyby distance upon reaching the asteroid Gaspra to about 1000 miles. It will be the first asteroid flyby. Galileo's partly deployed high-gain antenna remains recalcitrant. On May 20, controllers oriented the spacecraft so that the antenna was in full sunlight for two days, hoping that heat would unstick it; however, this manipulation was to no avail, perhaps because the spacecraft is already beyond the orbit of Mars. Project officials stress a careful and cautious approach to the problem since the Jupiter encounter does not begin until the end of 1995. They hope that the even greater temperature extremes the craft will experience as it swings back to Earth after February may correct the problem. The Gaspra encounter can use tape recorders to gather data for later transmission to Earth.

The classification of 951 Gaspra as an S-type revives the controversy over composition of these asteroids. In late July, The Meteoritical Society and the AAS's Division for Planetary Science sponsored a joint session at the 54th Annual Meteoritical Society meeting in Monterey to review data and interpretations to set the stage for the Gaspra encounter in October.

SUCCESS OF ASTRO-1 SPURS SECOND FLIGHT

On May 20, NASA announced that a second Astro mission will fly aboard the space shuttle. "We are delighted to be able to refly this proven scientific performer," said Dr. Len Fisk, Associate Administrator for Space Science and Applications. Though plagued by a succession of pesky instrument and computer problems, Astro-1 returned high-quality data. One of the most exciting discoveries emerged from images obtained by the Ultraviolet Imaging Telescope (UIT). In early May, UIT team members identified hundreds of newly found hot, young, energetic stars among the some ten thousand stars in the central region of the Large Magellenic Cloud (LMC), a galaxy in the neighborhood of the Milky Way. It is likely that many of the newly discovered stars were formed at about the same time as the star that exploded to become Supernova 1987A. The implication is that several of the newly resolved stars could one day become supernovae as well.

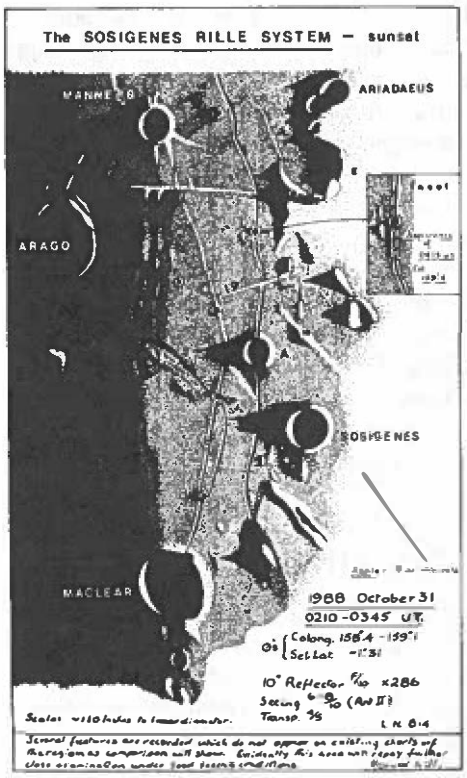


Using groundbased instruments, astronomers are unable to distinguish the higher-energy, blue ultraviolet emitters because the region of the LMC is dominated by less-energetic red stars. By isolating the most energetic stars, UIT is blazing a trail for detailed follow-up studies by the Hubble Space Telescope and the International Ultraviolet Explorer, as well as the Extreme Ultraviolet Explorer that will be launched in December.

Astro-2 will also be dedicated solely to astrophysics. In addition to the UIT, which images especially energetic components of nebulae, stars, and galaxies, Astro-2 will carry the Hopkins Ultraviolet Telescope, which allows analysis of chemistry and temperature through spectroscopy and the Wisconsin Ultraviolet Photopolarimeter Experiment, which examines the polarization of light from distant regions.

NEW IN PRINT

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



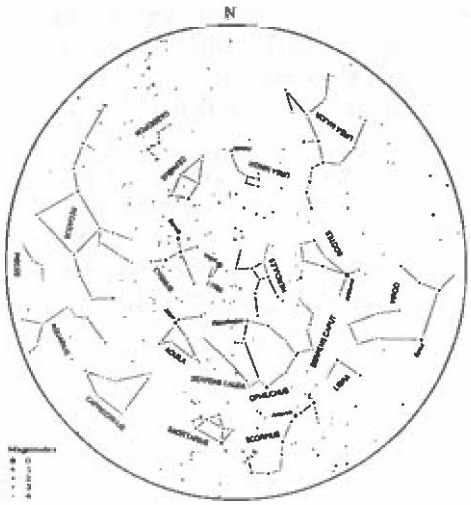
A REVIEW

A PORTFOLIO OF LUNAR DRAWINGS

By Harold Hill
Cambridge University Press, Cambridge, Great Britain 1991 240 pp.
Black and white illustrations. Hardcover, $49.50

The first in *The Practical Astronomy Handbook* series published by Cambridge, *A Portfolio of Lunar Drawings* presents a selection of the remarkable drawings of Briton Harold Hill, who has explored the lunar surface with telescope, pen, and ink for half a century. The most immediately striking thing about the drawings is how strange and wonderful they appear to eyes that have seen the Moon primarily through Lunar Orbiter and Apollo photography. Hill's selection of optimum Sun angle often reveals detail that is absent from lunar photography, and his series of drawings of a single feature from sunrise to sunset show just how crucial the lighting is to our interpretation of the surface. The selection of areas and features presented in the book is evidently guided by the areas that Hill finds interesting or otherwise understudied; Aristarchus and Copernicus are missing while lesser known regions are meticulously described.

"The production of worthwhile lunar observations necessitates something closely akin to hard work, as the concentration and co-ordination of hand and eye required, especially over long periods of perhaps difficult seeing and trying weather conditions, is, in my opinion, every bit as arduous as actual physical toil," writes Hill in his introductory essay on making lunar drawings. His hard work is abundantly apparent in the drawings themselves and in the extensive field notes that accompany them. The notes on the drawings bespeak a passion for exact, accurate selenography as do the minutely observed differences in appearance caused by Sun angle and libration. The collection should be of interest to anyone who seriously studies the lunar surface and to those who admire the tradition of lunar drawings begun by Galileo and continued by Harriot, Schroter, Schmidt, and others. Hill's work is a present-day link with that tradition, although one can't help but fear that these beautiful selenographic drawings may represent one of the last links. —P.T.



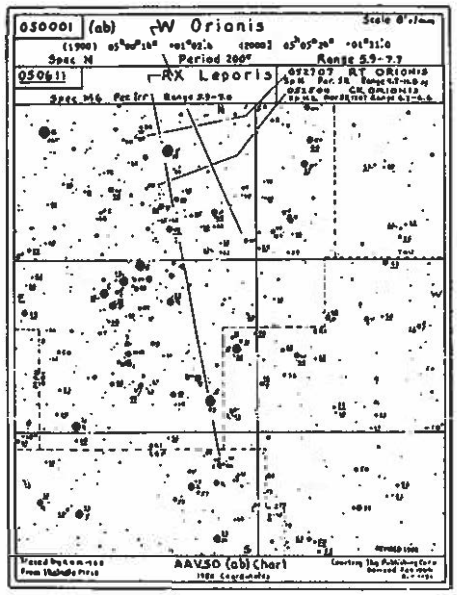
A REVIEW

THE SKY: A USER'S GUIDE

By David H. Levy
Cambridge University Press, Cambridge, Great Britain, 1991 295 pp.
Illustrated with photographs and drawings. Hardcover, $24.95

This is an excellent book for the serious amateur astronomer who really wants to learn the sky. The author, David H. Levy, is one of the world's leading amateur astronomers and a regular contributor to astronomy magazines, including *Sky & Telescope* and *Astronomy*. As the discoverer of six comets, Levy is an example of the contribution that amateurs can and do make to science.

The Sky: A User's Guide contains information on observing every type of visual object in the night sky, from aurorae to deep sky objects. The text is very readable and clear enough for novices to understand without being intimidated. Levy clearly explains the fundamentals of astronomy, such as the different types of telescopes, celestial coordinates, and how to use a star chart. Yet it is the experienced observer who will probably gain the most from this book. Several chapters contain tips on observing



objects such as meteors, sunspots, lunar transient phenomena, eclipses of all kinds, variable stars and other deep sky objects, planets, and of course comets. Through it all, Levy manages to convey the sense of wonder and sheer fun of stargazing.

What distinguishes *The Sky: A User's Guide* from all the others written for novices or amateurs are the training projects designed to teach users to locate and map distinct features in the night sky. If you follow these programs carefully, you will teach yourself how to find major lunar craters, Messier objects, and stars of interest, such as binaries and variables. These training exercises are designed to be carried out over many nights of observing and would form the basis of a good observation course for amateur clubs. Levy not only describes techniques for observing different types of objects, he also lists the best places to look for each of them. In addition, the book includes examples of forms on which to record your observations. This documentation approach is what separates the casual from the serious observer.

If you are interested in the night sky and really want to learn more about serious observing, then *The Sky: A User's Guide* is a must, no matter what your area of interest or experience level. —Eleta Malewitz

(Ms. Malewitz is a programmer at LPI; she is also an experienced amateur astronomer and current Vice President of the JSC Astronomical Society.)

NEW FROM THE ASTRONOMICAL SOCIETY OF THE PACIFIC

NEW CATALOG OF ASTRONOMY MATERIALS

A new catalog of educational materials on astronomy has been published by the nonprofit Astronomical Society of the Pacific. The 32-page, illustrated catalog includes video and audio tapes, slide sets, computer software, books, posters, observing aids, and video disks with the latest information from our exploration of the universe. New items include some outstanding picture books for children, video tapes from *The Astronomers* television series, a slide set on "The Sun in Action," and color posters of some of the most dramatic views of the universe. To order a catalog, send your name and address and two first-class stamps to: A.S.P., Catalog Requests Dept., 390 Ashton Avenue, San Francisco CA 94112.

VIDEO ON ROBOTIC ASTRONOMY

A new video program from A.S.P. documents the revolution in astronomy being achieved with robotic (automated) telescopes, which can make observations all night without the need for a human attendant. Made by the South Carolina Educational TV Network, the hour-long video was shot on location at observatories around the country and profiles both professional and amateur astronomers who are pioneering the use of these instruments for research and education. The program shows how a group of engineers, without much formal training in astronomy, are using new developments in computers and electronics to make small robotic observatories affordable to hobbyists and schools, thus encouraging wider participation in astronomical research and discovery. The VHS format video comes with a booklet with background information, a reading list, and suggested educational activities. $29.95 from A.S.P., Stargazer Orders Dept., 390 Ashton Avenue, San Francisco CA 94112.

LISTING OF ASTRONOMICAL SOFTWARE

An annotated listing of astronomical software, featuring information about more than 150 programs, is available from the A.S.P. The programs include simulations, planetaria (or star charts) for computers, databases, calculation aids, games, tele-

scope and observing aids, tutorials, lesson plans, and solar system displays. Also included are addresses and phone numbers of vendors, sources and dates of pertinent reviews, and a reading list on astronomical software. $4.00 from A.S.P., Software List Dept., 390 Ashton Avenue, San Francisco CA 94112.

NEW TECHNICAL REPORT FROM LGI

Technical Report 91-01 has been published by the Lunar Geotechnical Institute. It is available free from the Institute and is entitled "Mining on the Moon II," Proceedings of a Technical Session at the 1991 Annual Meeting, Society for Mining, Metallurgy, and Exploration, Inc., Salt Lake City, TR91-01. Order from LGI, P.O. Box 5056, Lakeland FL 33807-5056. Phone: 813-646-1842; FAX: 813-644-5920.

NEW FROM LPI

The following publications are available only from the Lunar and Planetary Institute.

SCIENTIFIC RATIONALE AND REQUIREMENTS FOR A GLOBAL SEISMIC NETWORK ON MARS

Sean C. Solomon, Don L. Anderson, W. Bruce Banerdt, Rhett G. Butler, Paul M. Davis, Frederick K. Duennebier, Yosio Nakamura, Emile A. Okal, and Roger J. Phillips.
LPI Technical Report LPI/TR--91-02

This publication reports the results of a workshop convened to define the scientific rationale and technical requirements for a global seismic network on Mars. The network would help determine the internal structure and constitution of the planet and the characteristics of marsquakes and meteoroid impacts. The report includes a brief overview of the mission concepts for a Mars Global Network Mission as of the time of the workshop, discusses the value of extraterrestrial seismology gained from experience to date on the Moon and on Mars, offers the basis for a strategy for station siting, and defines the technical requirements for the seismic stations.

The workshop was held May 7-9, 1990, in Morro Bay, California, and was attended by 10 scientists with interest and expertise in seismology and martian geophysics.

WORKSHOP ON MARE VOLCANISM AND BASALT PETROGENESIS: "ASTOUNDING FUNDAMENTAL CONCEPTS (AFC)" DEVELOPED OVER THE LAST FIFTEEN YEARS

Lawrence A. Taylor and John Longhi
LPI Technical Report LPI/TR--91-03

This workshop, sponsored by the LPI and the Lunar and Planetary Sample Team (LAPST), provided a forum for discussion of new results in the study of mare volcanism and the genesis of basaltic magmas. Of equal interest were the new petrogenetic modeling techniques and the implication of increased use of computers in all aspects of lunar scientific endeavors.

The workshop was held in Dallas, Texas, October 27-28, 1990.

PUBLICATIONS FROM LPI

QUANTITY	CODE	TITLE	PRICE	TOTAL
		BOOKS		
	PRO-3	PROCEEDINGS OF THE THIRD LUNAR SCIENCE CONFERENCE (LIMITED QTY.)	$15.00	
	PRO-20	PROCEEDINGS OF THE TWENTIETH LUNAR AND PLANETARY SCIENCE CONFERENCE	$50.00	
	PRO-21	PROCEEDINGS OF LUNAR AND PLANETARY SCIENCE, VOLUME 21	$50.00	
	B-ORIGINS	ORIGIN OF THE MOON	$25.00	
	B-BASES	LUNAR BASES AND SPACE ACTIVITIES OF THE 21ST CENTURY	$20.00	
	B-PLANS	PLANETARY SCIENCE: A LUNAR PERSPECTIVE (SPECIAL PRICE; SLIGHTLY DAMAGED)	$15.00	
		SLIDE SETS		
	S-WINDS	THE WINDS OF MARS: AEOLIAN ACTIVITY AND LANDFORMS	$15.00	
	S-TOUR	A SPACECRAFT TOUR OF THE SOLAR SYSTEM	$17.00	
	S-STONES	STONES, WIND, AND ICE: A GUIDE TO MARTIAN IMPACT CRATERS	$15.00	
	S-VOLC	VOLCANOES ON MARS	$12.00	
	S-APOLLO	APOLLO LANDING SITES	$17.00	
	S-OCEANS	SHUTTLE VIEWS THE EARTH: THE OCEANS FROM SPACE	$17.00	
	S-CLOUDS	SHUTTLE VIEWS THE EARTH: CLOUDS FROM SPACE	$17.00	
	S-GEOL	SHUTTLE VIEWS THE EARTH: GEOLOGY FROM SPACE	$17.00	
		TECHNICAL REPORTS AVAILABLE FOR THE COST OF SHIPPING AND HANDLING, EXCEPT 88-03		
	86-04	WORKSHOP ON EARLY CRUSTAL GENESIS	$0.00	
	87-02	MARTIAN GEOMORPHOLOGY AND ITS RELATION TO SUBSURFACE VOLATILES	$0.00	
	87-03	MARTIAN CLOUDS DATA WORKSHOP	$0.00	
	88-01	PROGRESS TOWARD A COSMIC DUST COLLECTION FACILITY ON SPACE STATION	$0.00	
	88-03	ASTRONAUT'S GUIDE TO TERRESTRIAL IMPACT CRATERS	$6.00	
	88-05	MEVTV WORKSHOP ON NATURE AND COMPOSITION OF SURFACE UNITS ON MARS	$0.00	
	88-07	WORKSHOP ON MARS SAMPLE RETURN SCIENCE	$0.00	
	89-02	ANTARCTIC METEORITE LOCATION AND MAPPING PROJECT	$0.00	
	90-01	WORKSHOP ON DIFFERENCES BETWEEN ANTARCTIC AND NON-ANTARCTIC METEORITES	$0.00	
	90-02	WORKSHOP ON LUNAR VOLCANIC GLASSES	$0.00	
	90-03	WORKSHOP ON ANTARCTIC METEORITE STRANDING SURFACES	$0.00	
	90-04	MEVTV WORKSHOP ON THE EVOLUTION OF MAGMA BODIES ON MARS	$0.00	
	90-05	WORKSHOP ON COSMOGENIC NUCLIDE PRODUCTION RATES	$0.00	
	90-06	SCIENTIFIC RESULTS OF THE NASA-SPONSORED STUDY PROJECT ON MARS: EVOLUTION OF VOLCANISM, TECTONICS, AND VOLATILES	$0.00	
	91-01	WORKSHOP ON PRODUCTION AND USES OF SIMULATED LUNAR MATERIALS	$0.00	
	91-02	SCIENTIFIC RATIONALE AND REQUIREMENTS FOR A GLOBAL SEISMIC NETWORK ON MARS	$0.00	
	91-03	WORKSHOP ON MARE VOLCANISM AND BASALT PETROGENESIS: "ASTOUNDING FUNDAMENTAL CONCEPTS (AFC)" DEVELOPED OVER THE LAST FIFTEEN YEARS	$0.00	

(OVER PLEASE)

PAGE TOTAL $ _____

PUBLICATIONS FROM LPI

QUANTITY	CODE	TITLE	PRICE	TOTAL

BALANCE FROM PREVIOUS PAGE $ _____

ABSTRACT VOLUMES

AVAILABLE FOR THE COST OF SHIPPING AND HANDLING

	ABS-14	LPSC XIV (1983)	$0.00	
	ABS-15	LPSC XV (1984)	$0.00	
	ABS-16	LPSC XVI (1985)	$0.00	
	ABS-18	LPSC XVIII (1987)	$0.00	
	ABS-21	LPSC XXI (1990)	$0.00	
	ABS-22	LPSC XXII (1991)	$0.00	

Shipping and Handling Charges

	U.S.	Canada Foreign Surface	Foreign air Europe/S Am	Foreign Air Pacific Ocean
Each 20th, 21st Proceedings	$9.00	$9.00	$36.00	$36.00
Each 3rd Proceedings	$10.00	$25.00	$75.00	$95.00
Each Book	$5.00	$5.00	$28.00	$28.00
One Slide Set	$3.00	$3.00	$7.00	$7.00
Ea. Additional Set, add:	$1.00	$1.00	$2.00	$2.00
One Technical Report	$6.00	$6.00	$10.00	$10.00
Ea. Additional Report, add:	$1.00	$1.00	$2.00	$2.00
Each Abstract Set	$10.00	$15.00	$55.00	$75.00

SUBTOTAL $ _____

SHIPPING AND HANDLING $ _____
(SEE CHART AT LEFT)

ADD 7.25% SALES TAX $ _____
FOR TEXAS DELIVERY
(APPLY TAX TO SUBTOTAL AND SHIPPING)

TOTAL AMOUNT ENCLOSED $ _____

PRICES EFFECTIVE THROUGH 12/91

Method of Payment

☐ Check (in U.S. dollars drawn on U.S. bank) ☐ Money Order

☐ VISA

☐ MasterCard

Account Number

Expiration Date

Print exact name appearing on credit card

Signature _____

Phone (____) _____ FAX (____) _____

PLEASE INDICATE BUSINESS HOURS PHONE.

PLACE ALL ORDERS WITH:

Order Department • Lunar and Planetary Institute • 3303 NASA Road 1 • Houston TX 77058-4399 • PHONE: (713) 486-2172 • FAX: (713) 486-2186

Ordered By

Organization _____

Name _____

Address _____

City _____

State _____ Zip _____

Phone (____) _____ (required to process order)

PLEASE INDICATE BUSINESS HOURS PHONE.

Ship To All domestic orders must ship to a street address only.

Organization _____

Name _____

Address _____

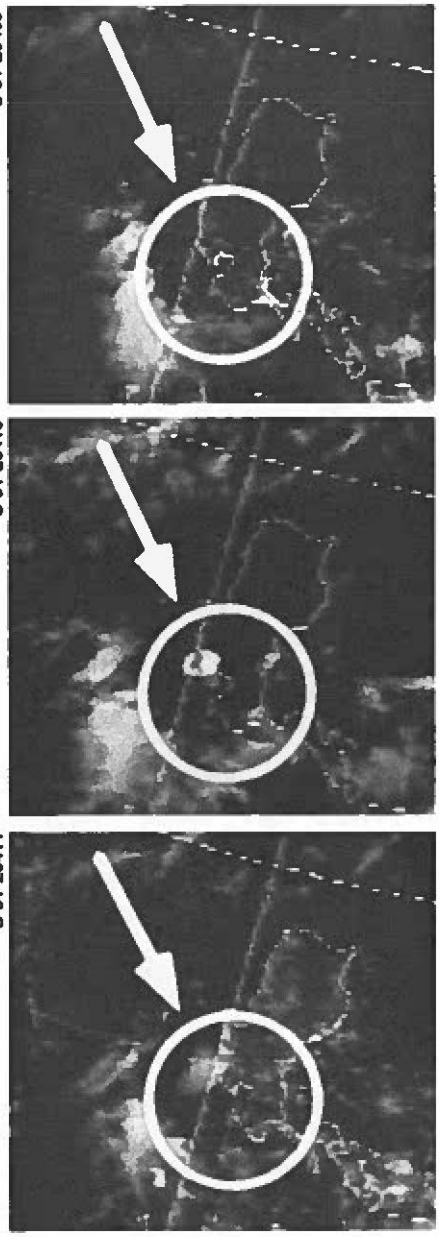
City _____

State _____ Zip _____

Phone (____) _____ (required to process order)

PLEASE INDICATE BUSINESS HOURS PHONE.

Data from Mt. Pinatubo Will Test Models of Earth's Climate



The series of three images shows Mt. Pinatubo one hour before eruption, during eruption, and one hour after eruption (top to bottom). The pictures were obtained from a Japanese weather satellite.

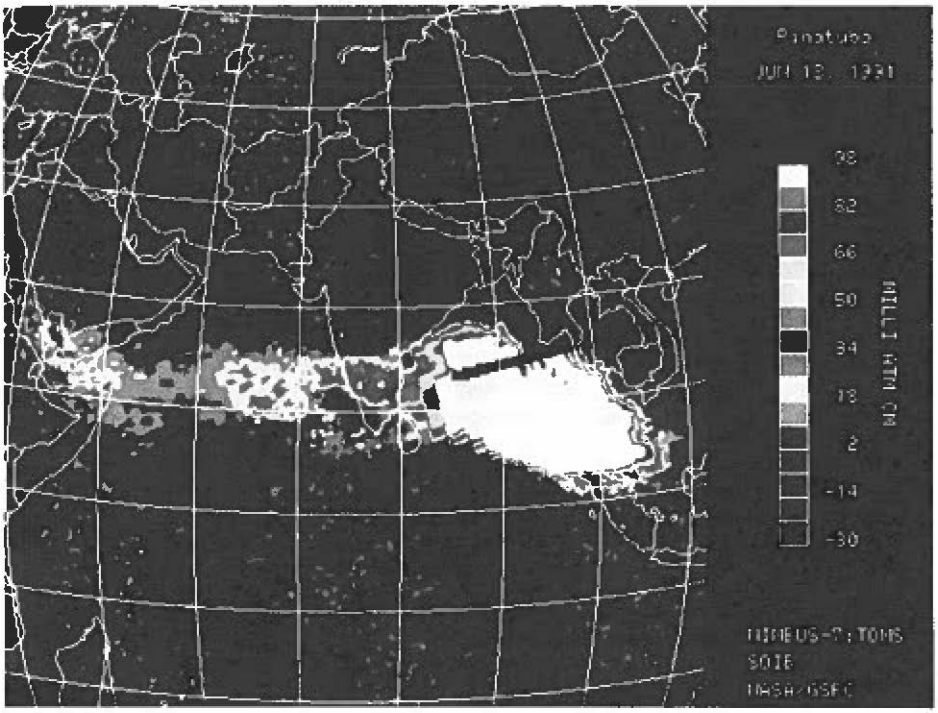
Preliminary data estimates from a NASA satellite indicate a 4800-mile-long cloud of sulfur dioxide has spread across the tropical Northern Hemisphere from the massive eruption of Mt. Pinatubo in the Philippines. By June 25, the cloud had drifted 4800 miles since the June 16 eruption, according to atmospheric scientist, Dr. Arlin Krueger of Goddard Space Flight Center. The data were gathered by the Total Ozone Mapping Spectrometer (TOMS) carried by the NIMBUS-7 satellite that measures ozone levels and monitors sulfur dioxide emissions. TOMS allows scientists to track the stratospheric plumes caused by large eruptions and measure the amount of sulfur dioxide (SO_2) injected into the atmosphere.

The effects of the Pinatubo cloud will be important not only in assessing the impact of large eruptions on Earth's climate, but in testing and modifying current climate models as well.

Sulfur dioxide is a toxic gas known best as a major cause of air pollution. In the atmosphere, it reacts with water to form sulfuric acid aerosols. These aerosols have been shown, in even smaller quantities than those formed by Pinatubo, to have measurable effects on regional climates. Mt. Pinatubo, an andesitic stratovolcano, has already produced twice as much SO_2 as was measured from El Chichon in 1982, and may well be the largest eruption of the century.

"What people can expect this fall are rosy sunsets as a result of aerosol particles produced from the cloud," Krueger said. "There also is a possibility that the cloud will reflect back into space some of the sunlight that would have reached the ground, resulting in a small change in the heat balance of the Earth."

A team of NASA atmospheric scientists based in Barbados will fly the NASA Lockheed Electra sampling platform to measure plume base, thickness, particle shape, spatial distribution, direct-diffuse radiation, optical depth, and vertical columns of SO_2 and HCl. Team leader Dr. M. Patrick McCormick, of NASA Langley, says, "Volcanic aerosols are climate 'forcers' so it is urgent we get an early characterization of the stratospheric plume. This effort will influence a number of future activities, including measurement scenarios for ground- and satellite-based sensors and development of chemical models of ozone depletion."



This NASA image, taken by the TOMS aboard the NIMBUS-7 satellite on June 18, shows the spread of a cloud of sulfur dioxide erupted by Mt. Pinatubo on June 16. The length of the entire cloud is 4000 miles; it has spread about 4800 miles from the Philippines in this image.

CALENDAR 1991

SEPTEMBER

2-4 **Planetary Radio Emissions III,** Graz, Austria. Contact: Helmut O. Rucker, Space Research Institute, Halbarthgasse 1, A8010 GRAZ, Austria.

16-20 **8th International Conference on Modern Trends in Activation Analysis (MTAA 8),** Vienna, Austria. Contact: Eva Haberl, MTAA 8, c/o Atominstitut, Schuttelstrasse 115, A-1020 Wien, Austria.

23-24 **Gamma Ray Observatory Science Workshop,** Greenbelt, Maryland. Contact: Chris Shrader, GRO Science Support Center, Code 668.1, Goddard Space Flight Center, Greenbelt MD 20771. Phone:301-286-7780; FAX: 301-286-9269.
SPAN: GROSSC(7073)::SHRADER
Internet: shrader@grossc.gsfc.nasa.gov

23-25 **Workshop on the Martian Surface and Atmosphere Through Time(MSATT),** Boulder, Colorado. Contact: Program Services Department, LPI, 3303 NASA Road 1, Houston TX 77058-4399. Phone: 713-486-2166; FAX: 713-486-2162.

30 – Oct 2 **Comets and the Origins and Evolution of Life,** University of Wisconsin-Eau Claire. Contact: Paul J. Thomas, Department of Physics and Astronomy, University of Wisconsin, Eau Claire WI 54702-4004. Phone: 715-836-5046; FAX: 715-836-2380.

OCTOBER

1-3 **Desktop Publishing in Astronomy and Space Sciences,** Strasbourg, France. Contact: Dr. Andre Heck, Observatoire Astronomique, 11, rue de l'Universite, F-67000 Strasbourg, France. Phone: 33-88.35.82.22; FAX: 33-88.25.01.60; Telex: 890506 starobs f.

5-10 **Twenty-eighth Annual Meeting of Clay Minerals Society,** Houston, Texas. Contact: D. R. Pevear, Exxon Production Res., P. O. Box 2189, Houston TX 77001. Phone: 713-529-8909.

16-18 **Huntsville Gamma-Ray Burst Workshop 1991,** Huntsville, Alabama. Contact: Dannah McCauley, USRA, 4950 Corporate Drive NW, Suite 100, Huntsville AL 35806. Phone: 205-895-0582; FAX: 205-895-9222.
SPAN: batse::workshop
Internet: workshop@batse.msfc.nasa.gov

21-24 **Geological Society of America Annual Meeting,** San Diego, California. Contact: Vanessa George, GSA, P.O. Box 9140, 3300 Penrose Place, Boulder CO 80301. Phone: 303-447-2020.

OCTOBER (CONTINUED)

22-23 **Third Annual Conference: Earth Observations and Global Change Decision Making: A National Partnership,** National Press Club, Washington, DC. Contact: Dr. Robert H. Rogers, ERIM, Box 8618, Ann Arbor MI48107-8618. Phone:313-994-1200, extension3234; FAX: 313-994-5123.

NOVEMBER

4-8 **23rd Annual Meeting of the Division for Planetary Sciences of the American Astronomical Society,** Palo Alto, California. Contact: Christopher P. McKay, Space Sciences Division, NASA Ames Research Center, Moffett Field CA 94035. Phone: 415-694-5499.

12-15 **The First International Design for Extreme Environments Assembly (IDEEA ONE),** Houston, Texas. Contact: IDEEA ONE Program Office, College of Architecture, University of Houston, Houston TX 77204-4431. Phone: 713-749-1181; FAX: 713-747-6230.

DECEMBER

6-8 **Workshop on the Physics and Chemistry of Magma Oceans from 1 Bar to 4 MBar,** San Francisco area, California. Contact: Program Services Department, LPI, 3303 NASA Road 1, Houston TX 77058-4399. Phone: 713-486-2166; FAX: 713-486-2162.

9-13 **American Geophysical Union, Fall Meeting,** San Francisco, California. Contact: AGU Meetings, 2000 Florida Avenue NW, Washington DC 20009. Phone: 202-462-6903.

JANUARY 1992

6-10 **Neptune and Triton, An International Meeting,** Tucson, Arizona. Contact: Dale Cruikshank, MS 245-6, NASA Ames Research Center, Moffett Field CA 94035. Phone: 415-604-4244; FAX: 415-604-6779.

13-15 **Mountain Belts on Venus and Earth,** San Juan Capistrano, California. Contact: Program Services Department, LPI, 3303 NASA Road 1, Houston TX 77058-4399. Phone: 713-486-2150; FAX: 713-486-2162.

MARCH 1992

1-5 **4th International Symposium on Experimental Methods for Microgravity Materials Science Research,** San Diego, California. Contact: Dr. Robert Schiffman, Symposium Chairman, 1960 Saunders Road, Riverwoods IL 60015. Phone/FAX: 708-940-7417.

2-6 **IAU Symposium 154 Infrared Solar Physics 1μm to 1 mm,** Tucson, Arizona. Contact: Douglas Rabin, National Solar Observatory, P.O. Box 26732, Tucson AZ 85726-6732. Phone: 602-325-9331; FAX: 602-325-9278.
SPAN: 5355::rabin
Internet: rabin@noao.edu

16-20 **23rd Lunar and Planetary Science Conference,** Houston, Texas. Contact: Program Services Department, LPI, 3303 NASA Road 1, Houston TX 77058-4399. Phone: 713-486-2166; FAX: 713-486-2162.

MARCH 1992 (CONTINUED)

17-20 **Recent Advances in High Energy Astronomy,** Toulouse, France. Contact: Pierre Mandrou, 9 Av. du Colonel Roche, 31027 Toulouse France. Phone: 33-61.55.66.88; FAX: 33-61.55.67.01; Telex: 531729 UNSPAT Toulouse.
SPAN: 17449::RAMON

23-27 **AGU Chapman Conference on Climate, Volcanism, and Global Change,** Hilo, Hawaii. Contact: Stephen Self, Department of Geology and Geophysics, University of Hawaii at Manoa, Honolulu HI 96822; or Richard P. Turco, Department of Atmospheric Sciences, University of California at Los Angeles, Los Angeles CA 90024-1565.

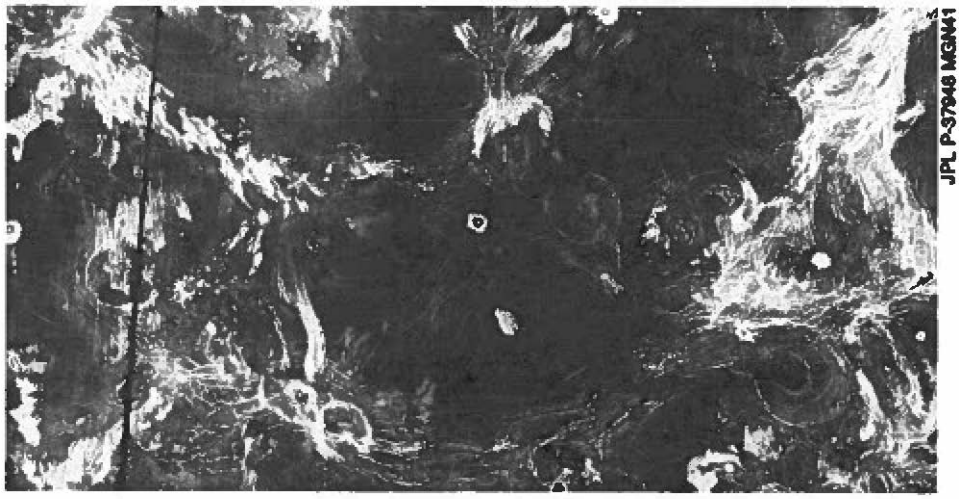
Magellan Embarks on Second Mapping Cycle

In its first 243-day cycle, Magellan had mapped 84% of Venus; the basic mission goal of 70% coverage was met as early as April 3. Cycle 2 began immediately after the first cycle ended on May 15. The spacecraft's radar will be right-looking during this cycle to provide opposite lighting and a different perspective to features mapped in the first cycle. In some cases, Magellan will reimage some volcanic areas with the same geometry as the first cycle so scientists can examine these regions for changes in lava flows, which would mean that volcanos are erupting and that Venus is geologically active.

Unusual volcanos with petal-shaped flows have been imaged that are different from most other volcanos on Venus. The lack of weathering or erosion by water on Venus allows scientists to see an entire sequence of volcanism preserved, according to Dr. Jim Head, a Magellan science team member from Brown University.

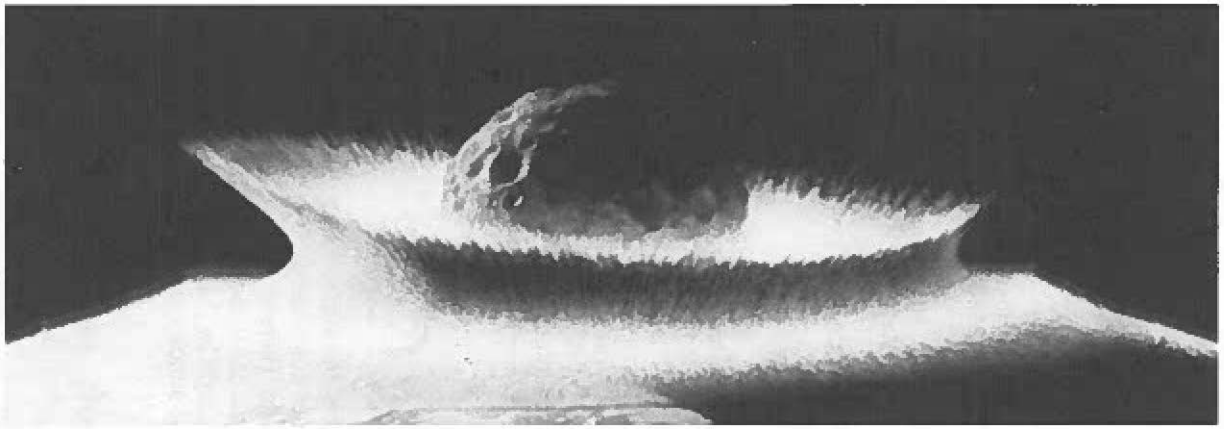
A recently discovered flow found in a highly fractured region may be significant in telling scientists where and how melting of rock is taking place in the interior of the planet, he said. "This deposit may represent an eruption like those that are currently happening in Japan and the Philippines. On Earth, the atmospheric pressure is such that when the gas-rich molten material reaches the surface, the resulting eruption sends the material up into the atmosphere in plumes, spreading it over large areas as it falls out of the atmosphere," Head explains.

"On Venus, the surface atmospheric pressure is about nine times higher than on Earth and when the gas-rich molten material reaches the surface, it may not form into plumes but instead may flow out over the surface. Therefore this may be an eruption like the one in the Philippines, but changed in its style by the very different conditions of the atmosphere," he said.



This mosaic shows a portion of an area in Bereghinya Planitia 1145 miles wide by 1002 miles centered at 45 degrees N, 11 degrees E. The most prominent features are arachnoids that range from 35-155 miles in size. They are thought to be of volcanic origin and are marked by concentric ridges and fractures. Arachnoids are frequently found in groupings connected by fractures that are radial to the individual structures. One theory suggests that they are an early stage of corona formation. Other volcanic features, small volcanic shields and pancake domes, as well as a large circular corona, can be seen in the image.

INSIDE



DINOSAURS' DEMISE? SEE PAGE 3

Universities Space Research Association USRA

LUNAR AND PLANETARY INSTITUTE
3303 NASA Road 1
Houston TX 77058-4399

ADDRESS CORRECTION REQUESTED

NON-PROFIT
U.S. POSTAGE PAID
PERMIT NO. 600
HOUSTON TX