

LUNAR SCIENCE INFORMATION BULLETIN

NUMBER 12

March 1977

Universities Space Research Association

LUNAR SCIENCE INSTITUTE

3303 NASA Road #1

Houston, TX 77058

713/488-5200

USRA

CONFERENCE TIME IN HOUSTON — 14-18 MARCH 1977

Plans for the Eighth Lunar Science Conference are on schedule. The Program Committee co-chaired by Dr. Michael B. Duke (NASA/Johnson Space Center) and Dr. Robert O. Pepin (Lunar Science Institute) met 27-29 January to consider the 360 abstracts submitted for publication and to prepare a program for the conference. Nineteen sessions, with approximately 235 oral presentations, were structured to address the seven major subject areas:

1. Constraints on structure and composition of planetary interiors
2. Characteristics and movements of materials on lunar, planetary and asteroidal surfaces
3. Characterization and evolution of maria and other volcanic landforms
4. Characterization and evolution of planetary crusts
5. Nature and effects of impact processes
6. Extraterrestrial materials as solar/interplanetary/interstellar probes
7. Earliest history of the solar system

PROGRAM HIGHLIGHTS SEE PRELIMINARY PROGRAM AND ENCLOSURE FOR DETAILS

Monday 8:30 a.m. The first plenary session will include an "Outlook for Space Science — '78" by Dr. Noel Hinners, and the presentation of samples from the Luna 24 mission to NASA from the Academy of Sciences of the USSR.

Monday 8:00 p.m. The Nassau Bay Hotel will be the scene for the all conference smoker.

Tuesday 1:30 p.m. Special session on Mars chaired by Dr. Thomas A. Mutch.

Tuesday 8:00 p.m. Report of the La Jolla Consortium open to all conference attendees, chaired by Dr. James Arnold and Dr. Isidore Adler.

Wednesday 8:00 p.m. Special session, open to conference attendees and the public on *New Moons: Towing Asteroids into Earth Orbits for Exploration and Exploitation* chaired by Prof. G. Arrhenius and Dr. David R. Criswell.

Friday 8:30 a.m. Summary session on each of the seven conference topics.

Registration will begin Sunday, March 13, 6-10 p.m. at the Nassau Bay Hotel and will continue through the Conference in Building 2, Auditorium at the Johnson Space Center from 8:00 a.m. to 5:00 p.m. Monday through Thursday and 8:00 to 11:00 a.m. Friday.

LUNAR SCIENCE VIII: ABSTRACTS OF PAPERS SUBMITTED TO THE EIGHTH LUNAR SCIENCE CONFERENCE will be given to Attendees at the Conference and will be available after the Conference by remitting \$1.00 for U.S. mailing and \$6.00 for foreign mailing to Ms. Carolyn Watkins, LSI.

JSC COMBINES SCIENCE ORGANIZATIONS

Dr. Richard S. Johnston has been named Director of Space and Life Sciences at the NASA/Johnson Space Center, in a merger of two Center organizations — the Life Sciences Directorate and the Science and Applications Directorate. The reorganization was effective in mid-January.

Mr. Peter J. Armitage is Assistant Director for Plans and Programs, Dr. Lawrence F. Dietlein is Assistant Director for Life Sciences, and Dr. Owen K. Garriott is Assistant Director for Science.

The new organization absorbs the five divisions in the former directorates: Science Payloads Division, Space Research and Operations Division, Bioengineering Systems Division, Earth Observations Division, and Lunar and Planetary Sciences Division.

ASSIGNMENT CHANGES AT NASA HEADQUARTERS

Following the retirement of Col. Arthur Strickland, Program Chief, Cartography, in the Lunar and Planetary Programs Office, Mr. Stephen E. Dwornik has been assigned the responsibility for the Lunar Cartography Program along with his other duties as Chief, Planetary Geology, which includes all planetary cartography. Mr. William Shirey, who has also been associated with the Lunar Cartography Program, has completed his tour of duty with NASA and returned to the Defense Mapping Agency Topographic Center. Ms. Mary Jo Smith will be coordinating the work on the Lunar Laser Ranging Program.

GOING SOMEWHERE!!!!

Getting a new mailing address for any reason at all? PLEASE let us know of any change of address. For every BULLETIN returned to us by the post office with either a forwarding address, an "addressee unknown", or "moved left no forwarding" we are charged 25¢. We then use first class postage to forward the mail to you. If the mail is returned to us with no forwarding address, we have no choice but to delete the name from the mailing list. You may be missing information or having your mail from the Institute needlessly delayed. Please send your address change to: LUNAR SCIENCE INSTITUTE, ATTENTION LSIB.

NEW PUBLICATION ON THE MOON

A new publication entitled "*What's New on the Moon?*" has been produced at NASA Headquarters. The author is Dr. Bevan M. French, Program Chief, NASA Extraterrestrial Materials Research Program. A geologist, French has studied lunar samples and terrestrial meteorite craters for more than ten years. The booklet, replete with dramatic photographs and diagrams, reviews the events that led to Moon landings and delineates many of the findings that resulted from Apollo missions to the Moon. The booklet is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 as Stock No. 033-000-00653-5. A single copy is \$1.00; multiple copies are \$.70 each. The text with colored pictures is to be published in the March and April issues of SKY AND TELESCOPE.

SPACE PHOTO ALBUM OF THE WORLD PREPARED FROM SATELLITE IMAGERY

The most comprehensive and detailed "space photo album" of the world's natural and cultural features has been prepared with images from NASA's Landsat Earth Resources satellite by Nicholas M. Short, Paul D. Lowman, Jr., and Stanley C. Freden of NASA's Goddard Space Flight Center, and Dr. William A. Finch, Jr., of the San Diego State University. Titled *Mission to Earth: Landsat Views the World*, the atlas size publication contains some 400 Landsat images, most of them in color and near full page size. It will be available by early March 1977, through the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 at \$14.00 per copy. The stock number is 033-000-00659-4.

Because of the value of the book to educators, an Educator's Guide is being prepared by the Goddard Center, and will be available at no cost upon request to the Center's Office of Public Affairs, Educational Programs, Greenbelt, MD 20771. The guide contains a "Teacher's Resource Section" which includes classroom activities, exercises and techniques for using the imagery. To facilitate the use of *Mission to Earth* by the teacher, the guide includes a glossary of geological and remote sensing terms which are used in the book.

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

Editor: Frances B. Waranius, Lunar Science Institute
3303 NASA Road #1
Houston, TX 77058 U.S.A.
(phone: 713/488-5200 x.35)

CALENDAR

- 14-18 March EIGHTH LUNAR SCIENCE CONFERENCE
Johnson Space Center
Houston, TX
see PAGE 1 and enclosures
- 18 April DEADLINE for manuscripts for Eighth Lunar
Science Conference
Publications Office, LSI
- 9-12 May Third Princeton/AIAA Conference on Space
Manufacturing Facilities
CONTACT: Conference Office
Princeton University
5 Ivy Lane
Princeton, NJ 08540
Telephone: 609/425-3371
- 30 May - 3 June American Geophysical Union Spring Meeting
Washington, DC
CONTACT: AGU
1909 K Street, N.W.
Washington, DC 20036
- 25-29 July Meteoritical Society Annual Meeting
University of Cambridge, England
CONTACT: Dr. E. R. D. Scott
Dept. of Mineralogy & Petrology
Downing Place
Cambridge CB2 3EW England
- 9-19 August International Associations of Volcanology and
Chemistry of the Earth's Interior and of
Seismology and Physics of the Earth's
Interior
Durham, UK
CONTACT: R. E. Long
IASPEI/IAVCEI Assembly Office
Dept. of Geological Sciences
University of Durham
South Road
Durham DH1 3LE England
- 25 Sept. - 1 Oct. International Kimberlite Conference
Santa Fe, New Mexico
CONTACT: Lois Elms
745 Gilpin Drive
Boulder, CO 80303
See EOS p. 870, December 1976 for details

PRELIMINARY PROGRAM

EIGHTH LUNAR SCIENCE CONFERENCE

March 14-18, 1977

Sponsored by
Lunar Science Institute
and
Lyndon B. Johnson Space Center

LSIB No. 12
Enclosure

		T O P I C						
		I	II	III	IV	V	VI	VII
Monday	a.m.							
	8:30	WELCOME IN A						
	a.m.							
	8:45	PLENARY SESSION IN A						
	p.m.							
Tuesday	2:00	A	G2					G1
	p.m.							
	8:00	SMOKER AT NASSAU BAY HOTEL						
	a.m.							
	8:30	B30				G2		G1
Wednesday	p.m.	INFORMAL SPECIAL INTEREST SESSIONS						
	a.m.		II & VI		A	G2		
	8:30		G1					
	p.m.		II & VI					
	1:30		G1	A	B30	G2		
Thursday	a.m.							
	8:30			G1	A		G2	
	p.m.							
	1:30		G2	A				G1
	a.m.							
Friday	8:30	SUMMARY SESSION IN A						
	p.m.	O P E N						

- A - Building 2 Auditorium
- G1 - Gilruth Center, Room 104
- G2 - Gilruth Center, Room 206
- B30 - Building 30 Auditorium
- Topic I - Constraints on structure and composition of planetary interiors.
- II - Characteristics and movements of materials on lunar, planetary and asteroidal surfaces.
- III - Characterization and evolution of maria and other volcanic landforms.
- IV - Characterization and evolution of planetary crusts.
- V - Nature and effects of impact processes.
- VI - Extraterrestrial materials as solar/interplanetary/interstellar probes.
- VII - Earliest history of the solar system.

CONFERENCE INFORMATION

MESSAGE CENTER

A Message Center will be established in the registration lobby. Persons who have a need to contact you during the Conference should be instructed to call Houston, Texas, Area Code 713/488-5071. The Message Center will be operational during each day of the Conference from 8:00 a.m. to 5:00 p.m. Messages will be posted on a bulletin board at the Message Center. There will be no paging during the Conference.

TRANSPORTATION ASSISTANCE

Assistance for arranging airline reservations is available from the Airlines Traffic Office in Room 130 of Building 1. Conference badges must be worn for entrance to this building. This service will be available each day of the Conference from 8:00 a.m. to 5:00 p.m.

SMOKER

A Cash Bar Smoker for all Conference participants and their wives/husbands/dates will be held on Monday, March 14, 1977, at 8:00 p.m. in the Nassau Bay Hotel, NASA Road 1.

THE LUNAR SCIENCE INSTITUTE OPEN HOUSE

Participants at the Conference are invited to visit the LSI between 9:30 a.m. - 12:00 noon and from 2:30 p.m. - 5:00 p.m. each day except Monday morning. Tours of the building of LSI will be given at 10:00 a.m. and 3:00 p.m. beginning Monday afternoon through Friday afternoon. The Institute is located in the James Marion West Mansion just past the east gate to the Johnson Space Center (JSC) on NASA Road 1.

NASA TOUR

Arrangements may be made in the registration lobby for a conducted tour of the JSC. Tours will require approximately 1-1/2 hours and will include visits to the Mission Control Center and Space Environmental Simulation Laboratory.

BREAKFAST AND LUNCHEON

Breakfast and luncheon will be available from restaurants and cafeterias within the JSC area. Two cafeterias are open at JSC, one in Building 3 and the other in Building 11. They are open from 7:00 a.m. to 2:00 p.m. Monday through Friday.

BUS SERVICE

A shuttle bus service between JSC, LSI, and the various motels/hotels will operate each day from 7:30 a.m. to 9:30 a.m., from 11:30 a.m. to 1:30 p.m., and from 5:00 p.m. to 6:30 p.m. In addition, a shuttle bus service will operate continuously between the Building 2 Auditorium and the Gilruth Recreation Center from 8:00 a.m. to 6:00 p.m.

PROGRAM COMMITTEE

The program was prepared on the basis of submitted abstracts. The Program Committee consisted of M. Duke (*Johnson Space Center*) and Robert O. Pepin (*Lunar Science Institute*), Co-Chairmen; Arden L. Albee (*California Institute of Technology*); Ghislaine Croaz (*Washington University*); Fraser Fanale (*Jet Propulsion Laboratory*); Bruce Goldstein (*NASA Headquarters*); John C. Huneke (*California Institute of Technology*); William M. Kaula (*University of California*); John F. Kerridge (*University of California*); Gary E. Lofgren (*Johnson Space Center*); Thomas McGetchin (*Los Alamos Scientific Laboratory*); Russell B. Merrill (*Lunar Science Institute*); Carle Pieters (*Mass. Institute of Technology*); Peter H. Schultz (*Lunar Science Institute*); Sean C. Solomon (*Mass. Institute of Technology*).

BADGES

During the period of the Conference, your Conference badge will allow you entrance to the various buildings where sessions are being held. Your JSC and LSI hosts will be pleased to offer any assistance.

REGISTRATION

Pre-registration will be on Sunday, March 13, 6:00 p.m. - 10:00 p.m. at the Nassau Bay Hotel. Registration will also be in Building 2, Johnson Space Center, 8:00 a.m. - 5:00 p.m. Monday through Friday.

Monday, March 14, 1977

Building 2 Auditorium
8:30 a.m.

WELCOME

Christopher C. Kraft, Jr.
Welcome

PLENARY SESSION

Building 2 Auditorium
8:45 a.m.

Chairmen: R. S. Johnston
G. J. Wasserburg

Noel Hinners
Outlook For Space Science - 78

J. Arnold
Additional Comments On The Outlook For Space Science

Presentation Of Luna 24 Samples To NASA By The Academy Of Sciences
Of The USSR

V. L. Barsukov, et al
The Lunar Soil From Mare Crisium: Preliminary Data
and
Preliminary Description Of The Regolith Core From Mare Crisium

W. Kaula
Why Is The Moon Different From The Earth In Bulk Composition?

Florensky, Basilevsky, Burba, Nikolaeva, Pronin, Volkov, Ronca
First Panoramas Of The Venusian Surface

Results From Viking Mission

Brownlee, Tomandl, Olszewski
*Interplanetary Dust; A New Source Of Extraterrestrial Material
For Laboratory Studies*

Monday, March 14, 1977

I-A. LUNAR EVOLUTION

Building 2 AUDITORIUM
2:00 p.m.

Chairmen: M. G. Langseth
G. W. Wetherill

Morgan, Higuchi, Takahashi, Hertogen
A "Chondritic" Eucrite Parent Body: Inference From Trace Elements

Dreibus, Kruse, Rammensee, Spettel, Wänke
*Cosmochemical Constraints On Planetary Compositions: Earth, Moon,
Eucrite Parent Body*

Taylor, Jakes
*Geochemical Evolution Of The Moon: Taylor-Jakes-Bence Models
Revisited*

Smith
Chemical Evidence On Origin Of Earth And Moon

Ringwood, Kesson
*Siderophile And Volatile Elements In The Moon And The Earth's Mantle:
Implications For Lunar Origin*

Longhi
Magma Oceanography: 2. Chemical Evolution

Solomon, Longhi
Magma Oceanography: 1. Thermal Evolution

Herbert, Drake, Sonett, Wiskerchen
Thermal History Of Lunar Magma Ocean

Runcorn
Concerning The Early Melting Of The Moon

Keihm, Langseth
Lunar Thermal Regime To 500 km

Meissner, Lange
*Comparative Calculations Of Temperatures And Viscosities In
Terrestrial Planets*

Toksöz, Hsui
Thermal Evolution Of Planetary Size Bodies

Goldstein, Phillips
*Consequences Of Possible Lunar FeS Distributions: Core, Pods, Or
Interstitial Veins*

Monday, March 14, 1977

VII-A. CONDENSATION AND EARLY HISTORY OF THE SOLAR SYSTEM I

Gilruth Center, Room 104
2:00 p.m.

Chairmen: F. Podosek
H. Takeda

Macdougall, Phinney
*Noble Gases And Particle Tracks In Olivine Crystals From Murchison
And Cold Bokkeveld*

Heymann
Solar Origin Of "Planetary" Neon?

Cadogan
Palaeoatmospheric Argon In Rhynie Chert

Frick, Moniot
Planetary Noble Gas Components In Orgueil

Flynn, Fraundorf, Shirck, Walker
*Negative Search For Fission Tracks From Superheavy Elements In
Allende*

Boynton
*Fractionation Of Th, U, Pu And Cm In The Early History Of The
Solar System: Implications For Dating Techniques*

Benjamin, Burnett, Ng, Seitz
Laboratory Studies Of Pu-U-Th Fractionation

Marti, Lugmair, Scheinin
Sm-Nd-Pu Systematics In The Early Solar System

Pellas, Storzer
Cooling Histories Of Stony Meteorites

Fukuoka, Ma, Schmitt
Genesis Of Howardites As Mixtures Of Eucrites And Diogenites

Drake, Consolmagno
*Asteroid 4 Vesta: Possible Bulk Composition Deduced From Geo-
Chemistry Of Eucrites*

Huneke, Smith, Rajan, Papanastassiou, Wasserburg
Comparison Of The Chronology Of The Kapoeta Parent Planet And The Moon

Wilkening, Parker
Nuclear Particle Track Studies Of The Pasamonte Eucrite

Monday, March 14, 1977

II-A. PLANETARY SURFACES

Gilruth Center, Room 206
2:00 p.m.

Chairmen: T. V. Johnson
T. B. McCord

Hapke
The Albedo Of Lunar Soil

McKay, Morris, Dungan, Bogard, Fruland
*Maturity Of Soil In Drive Tube 60009/10 And Implications For
Regolith Evolution*

Matson, Johnson, Veeder
*Soil Maturity And Planetary Regoliths: The Moon, Mercury And
Asteroids*

Gaffey, McCord
*Asteroid Surface Materials: Mineralogical Characterizations And
Cosmological Implications*

Zellner, Leake, Lebertre, Dollfus
Polarimetry Of Meteorites And The Asteroid Albedo Scale

Dollfus, Duseaux, Mandeville
Are Some Asteroids Pieces Of Metal?

Degewij
Small Asteroids And Collisional Fragments

Huguenin, Adams, McCord
Mars: Surface Mineralogy From Reflectance Spectra

Peterfreund, Kieffer, Palluconi
Thermal Inertia Of The Elysium Region Of Mars

Bell, Mao
Crystal-Field Spectra Of Fassaita From The Angra Dos Reis Meteorite

Sung, Singer, Parkin, Loeffler, Burns
*Temperature Dependencies Of Crystal Field Transition Energies And
Their Effect On The Mineralogical Mapping Of The Lunar Surface*

Criswell, De
*Photoelectric Charging And Pseudoconductivity Of Localized Sunlit
Areas On The Moon*

Alvarez
Fines Photoconductivity

Monday, March 14, 1977
8TH LSC SMOKER
NASSAU BAY HOTEL, NASA ROAD 1
8:00 p.m. - 11:00 p.m.

Tuesday, March 15, 1977
VII- B. CONDENSATION AND EARLY HISTORY OF THE SOLAR SYSTEM II

Gilruth Center, Room 104
8:30 a.m.

Chairmen: J. Kerridge
D. Macdougall

- Herbst, Assousa
Observational Evidence For Supernova-Induced Star Formation
- Kothari, Stephens
Experimental Approach To The Condensation In A Solar Nebula
- De
Thermal Physics Relevant To The Condensation Of Meteoritic Solids
- Arrhenius, Simpson
Molecular And Isotopic Processes In Space Condensation
- Wark, Lovering
Marker Events In The Early Evolution Of The Solar System: Evidence From Rims On Calcium-Aluminium-Rich Inclusions In Carbonaceous Chondrites
- Grossman, Davis, Olsen, Santoliquido
Chemical Studies Of Condensates In The Murchison Type 2 Carbonaceous Chondrite
- Haggerty
Refinement Of The Ti-Cosmometer In The Allende Meteorite And The Significance Of A New Mineral, $R^{2+}Ti_3O_7$, In Association With Armalcolite
- Hutcheon
Micro-Mineralogy Of Calcium-Aluminum-Rich Inclusions From Allende
- Wasserburg, Lee, Papanastassiou
Mg And Ca Isotopic Study Of Individual Microscopic Crystals From The Allende Meteorite By The Direct Loading Technique
- Epstein, Yeh
The $\delta^{18}O$, $\delta^{17}O$, $\delta^{30}Si$ And $\delta^{29}Si$ Of Oxygen And Silicon In Stony Meteorites And Allende Inclusions
- Woolum, Bies-Horn, Burnett, August
Bi Microdistributions In Chondrites
- Wasson, Boynton, Kallemeyn
Classification And Elemental Fractionation Among Carbonaceous Chondrite Classes
- Matza, Lipschutz
Retention Of Eleven Trace Elements In Murchison C2 Chondrite Heated From 400-1000°C

Tuesday, March 15, 1977

V-A. NATURE AND EFFECTS OF IMPACT CRATERING

Gilruth Center, Room 206
8:30 a.m.

Chairmen: M. Dence
D. Roddy

- O'Keefe, Ahrens
Partitioning Of Energy And The Degree Of Melting And Vaporization In Planetary Impact Processes
- Kieffer
The Role Of Volatiles In The Impact Process
- Simonds, Phinney, Warner
Effect Of Water On Cratering: A Review Of Craters And Impactites On The Earth, Moon and Mars
- Stöffler
Structure Of The Ries Crater And Distribution Of Target Rocks Within Different Types Of Impact Breccias
- Hörz, Gall, Hüttner, Oberbeck
Shallow Drilling In The "Bunte Breccia" Impact Deposits, Ries Crater, Germany
- Phinney, Warner, Simonds
Petrologic Evidence For Formation And Solidification Of Impact Melts
- Uhlmann, Klein, Pettyjohn
Crystallization Kinetics, Viscous Flow And Thermal History Of Lunar Breccia 62975
- Fruland, Morris, McKay
Apollo 17 Ropy Glasses
- Simmons, Siegfried, Richter, Hörz
Microcracks In Shocked Rock
- Schaal, Hörz
Shock Effects In Some Lunar Basalts
- Sclar, Bauer
Electron Petrography Of Shock-Induced Crystallographically Controlled Planar Features In Quartz
- Jeanloz
Electron Damage: A New Analytic Technique Applied to Plagioclase In Shocked Chondrites And Basalt
- Friel, Goldstein, Romig Jr.
The Effect Of Carbon On Phosphate Reduction

Tuesday, March 15, 1977

I-B. LUNAR STRUCTURE

Building 30 Auditorium
8:30 a.m.

Chairmen: J. Dorman
W. L. Sjogren

- Goins, Dainty, Toksöz
The Structure Of The Lunar Interior As Determined From Seismic Data
- Nakamura, Latham, Dorman, Horvath, Ibrahim
Seismic Indications Of Broad-Scale Lateral Inhomogeneities In The Lunar Interior
- Tittmann, Ahlberg, Nadler
Quality Factor Q Under Confining Pressure
- Mizutani, Spetzler, Getting, Martin III, Soga
The Effect Of Outgassing Upon The Closure Of Cracks And The Strength Of Lunar Analogues
- Horai, Winkler Jr., Keihm, Langseth Jr., Fountain, West
Thermal Conductivity Of Two Apollo 17 Drill Core Samples 70002 And 70006: A Preliminary Result
- Ferrari, Nelson, Sjogren, Phillips
The Isostatic State Of The Lunar Apennines And The Regional Surroundings
- Roth, Elachi, Phillips
Equipotential Doming In Flooded Circular Basins
- Smith, Banerdt, Sammis, Alexander
Tidal Stress Concentrations In A Laterally Heterogeneous Moon
- Kuckes
Lunar Gravity And Flexure Of A Thin Elastic Lithosphere
- Slade, Preston, Harris, Skjerve, Spitzmesser
ALSEP-QUASAR AVLBI Observations
- King, Ness
Data Accuracy Considerations For Lunar Permeability Studies
- Wiskerchen, Sonett
A Lunar Metal Core?
- Dyal, Parkin, Daily
Global Lunar Crust: Electrical Conductivity And Thermoelectric Origin Of Remanent Magnetism

Tuesday, March 15, 1977

AFTERNOON

The afternoon has been left free to accommodate special informal sessions which consider subjects that do not fit readily within the topical framework of the Conference. Descriptions of these sessions are included in your registration packet.

Wednesday, March 16, 1977

IV-A. EVOLUTION OF THE PLANETARY CRUST:
STUDY OF EARLY IMPACTITES AND THE NATURE OF THE EARLY CRUST

Building 2 Auditorium
8:30 a.m.

Chairmen: A. J. Irving
R. B. Merrill

- Jovanovic, Jensen, Reed Jr.
*Further Insights Into The Evolution Of The Early Moon:
I. Convection Cells, II. Ru-Os Partitioning And Mixing*
- Ryder, Wood
*Serenitatis And Imbrium Impact Melts: Implications For Lunar
Crustal Composition And Stratigraphy*
- Warren, Mittlefehldt, Boynton, Wasson
In Quest Of Primary Highlands Rocks
- Hertogen, Janssens, Takahashi, Palme, Anders
*A Moon-Like Planetesimal And Other Antiquities At North Ray Crater,
Apollo 16*
- Reid, Richardson, Duncan
Non-Mare "Igneous" Clasts In Apollo 15 Breccias
- Warner, Bickel, Phinney, Simonds
*Feldspathic, Granulitic Impactites That Pre-Date The Final Lunar
Bombardment*
- Nava, Winzer, Lindstrom, Meyerhoff, Lum, Schuhmann, Lindstrom, Philpotts
Rind Glass And Breccia: A Study Of Lunar Sample 15255
- Winzer, Meyerhoff
Petrography And Petrology Of Clasts From Consortium Breccia 61175
- Chao, Minkin, Thompson
*Petrology Of Consortium Sample 67455, From A White-Matrix Breccia
Boulder Near The Rim Of North Ray Crater, Descartes*
- Consortium Studies Of Breccias 73215 And 73255
- James, Marti
Consortium Breccia 73255
- James
Petrology Of Clasts
- Blanchard, Brannon, Jacobs, Haskin
*Major And Trace Element Abundances In Anorthositic Gabbro Clasts
And A Clast Of K-Rich Felsite From Consortium Breccia 73215*

Staudacher, Jessberger, Kirsten

^{40}Ar - ^{39}Ar Age Systematics Of Consortium Breccia 73215. II.

Müller, Plieninger, James, Schaeffer

Laser Probe ^{40}Ar - ^{39}Ar Dating Of Materials From Consortium Breccia 73215

Compston, Foster, Gray

Rb-Sr Systematics In Clasts And Aphanites From Consortium Breccia 73215

Wednesday, March 16, 1977

JOINT SESSION - II & VI-A.
PHYSICS AND CHEMISTRY OF THE LUNAR SURFACE

Gilruth Center, Room 104
8:30 a.m.

Chairmen: W. V. Boynton
J. A. M. McDonnell

Meyer Jr., Schonfeld

Ion Microprobe Study Of Glass Particles From Lunar Sample 15101

Basu

Exposure Age And Agglutinate Content Of Lunar Soils

Hu, Taylor

Agglutinate Formation: Lack Of Chemical Fractionation

Blanchard, Brannon

Effects On Composition Of Maturation In A Well Documented, Isochemical Suite Of Soils From Drive Tube 60009/10

Cirlin, Housley

An Atomic Absorption Study Of Volatile Trace Metals In Lunar Samples

Allen Jr., Jovanovic, Reed Jr.

Volatile Metals--Mode Of Transport

Krähenbühl, Grütter, von Guten, Meyer, Wegmüller, Wytttenbach

Distribution Of Volatile And Non-Volatile Elements In Grain-Size Fractions Of Apollo 17 Lunar Soils

Alexander Jr., Saito, Dragon, Coscio Jr., Pepin

^{40}Ar - ^{39}Ar And Rare Gas Studies Of Lunar Soils

Schultz, Weber, Spettel, Hintenberger, Wänke

Agglutinates: Noble Gas And Element Distribution In Grain Size Fractions Of The Apollo 15 Soil 15601

Signer, Baur, Derksen, Etique, Funk, Horn, Wieler

Light Noble Gas Records Of Lunar Soil Evolution

Bogard

Soil Maturation And Grain Size-Dependence Of Trapped Solar Gases

Wednesday, March 16, 1977

V-B. IMPACT CRATER FORMATION AND EVOLUTION

Gilruth Center, Room 206
8:30 a.m.

Chairmen: R. Pike, Jr.
N. J. Trask

- Roddy, Ullrich
*Cratering Subsurface Motion Sequences And Structural Deformation:
Experimental Techniques*
- Melosh
The Role Of Slumping In Crater Modification
- Dvorak, Phillips
The Subsurface Structure Of Large Young Lunar Craters
- Hawke, Head
Impact Melt In Lunar Crater Interiors
- Reh fuss, Michael, Anselmo, Kincheloe
Wind-Transport Of Ejecta And The Fragmentation Parameter
- Oberbeck, Aggarwal
Topography Of Lunar Secondary Craters And Implications
- Woronow
A Simulation Of The Lunar Highlands Crater Population
- Cintala, Wood, Head, Mutch
*Interplanetary Comparisons Of Fresh Crater Morphology:
Preliminary Results*
- Croft
Volumetric Studies Of Lunar Craters: Evidence For A Megaregolith
- Eppler, Nummedal, Ehrlich
*Large Scale Geologic Trends In Lunar Bedrock -- Fourier Analysis
Of Planimetric Crater Shape*
- Wood, Head, Cintala
*Degradation Trends Of Mercurian Craters And Correlation With The
Moon*
- Carusi, Fulchignoni, Poscolieri, Caputo, Casacchia, Parotto
*Mercury Cratering: Physiographic Units Statistical Recognition
And Their Evolutionary History*

Wednesday, March 16, 1977

III-A. KINETICS AND BASALT PETROGENESIS

Building 2 Auditorium
1:30 p.m.

Chairmen: J. Longhi
J. Papike

- Gibson Jr., Andrawes
The Role Of Sulfur In The Apollo 12 Basalts
- Knecht, Simons, Woermann, El Goresy
*The Chromium Concentration Of Ilmenite And Its Possible Application
As A Lunar Thermometer*
- Gatehouse, Grey, Lovering, Wark
Structural Studies On Tranquillityite And Related Synthetic Phases
- Cadenhead, Brown
Porosity, Or Its Absence, In Lunar And Terrestrial Samples
- Heiken, McKay
*Sample 74001 And Its Significance For Models For Eruption Behavior
Of A Volcanic Vent In Eastern Mare Serenitatis*
- Huggins, Huffman
*Effect Of Temperature And Composition On Superparamagnetic Clusters
Of Fe²⁺ Spins In Olivines - A Potential Thermal History Indicator*
- Taylor, Walker, Onorato, Uhlmann
Fe-Mg Diffusion In Olivine: A Cooling Rate Indicator
- Grove, Bence
*Pyroxenes As Recorders Of Lunar Basalt Petrogenesis Revisited: An
Experimental Study Of Pyroxene-Liquid Interaction*
- Walker, Longhi, Stolper, Grove, Hays
Slowly Cooled Microgabbros 15065 And 15555
- El Goresy, Ramdohr
*Apollo 17 TiO₂-Rich Basalts: Spinel Chemical Bimodality In The
Two Major Basalt Types And Genetic Significance Of Inverted Zoning
Of Chromian Ulvöspinel*
- Schreiber
*Ti(IV)-Ti(III), Eu(III)-Eu(II), And Cr(III)-Cr(II) Redox
Equilibria In Synthetic Silicate Melt Analogs Of Lunar Basaltic
Magmas*
- Roedder, Weiblen
*Differentiation Trends In Mare Lavas, As Indicated By Silicate Melt
Inclusions*

Wednesday, March 16, 1977

JOINT SESSION - II & VI-B.
PHYSICS AND CHEMISTRY OF THE LUNAR SURFACE

Gilruth Center, Room 104
1:30 p.m.

Chairmen: R. Fruland
E. Zinner

Büchler, Kiko, Kirsten, Plieninger, Warhaut
He And Ne Depths Profiles In Lunar Soil Particles

Hartung, Plieninger, Müller, Schaeffer
Helium, Neon, And Argon On Sunlit And Shaded Surfaces Of Lunar Rock 12054 By Laser Probe Mass Spectrometry

Hodges Jr.
Synodic Effects On The Escape Of Helium And Hydrogen From The Moon

Ivanov
On The Intensity Of Sodium Vaporization From the Mare Regolith

Filleux, Tombrello, Burnett
Direct Measurement Of Surface Carbon Concentrations

Pillinger, Gardiner, Jull, Woodcock, Stephenson
Carbon Systematics Of Lunar Soils: I. Studies On Agglutinates Separated From 15601

Morris
Fine-Grained Metal Distribution In Grain-Size Separates Of Lunar Soils: Production And Evolution Of The Fine-Grained Metal

Baron, Bilson, Gold, Colton, Hapke, Steggert
A Comparison Of ESCA-XPS And Auger Electron Spectroscopy For The Study Of The Surface Chemical Composition Of Lunar Soil Samples

Housley, Grant
An ESCA Study Of Reduced Fe And Other Surface Chemical Alteration Profiles In Lunar Fines

Russell, Papanastassiou, Tombrello, Epstein
Search For Ca Isotopic Fractionation And Correlation Of Ca And O Effects

Bibring, Chaumont, Dran, Lahu, Langevin, Maurette, Vassent
Solar Wind Erosion Of Lunar Dust Grains. A Progress Report

McDonnell
Accretionary Particles: Production And Equilibrium On 12054

Wednesday, March 16, 1977

V-C. DATING AND STATISTICS OF LUNAR CRATERS

Gilruth Center, Room 206
1:30 p.m.

Chairmen: R. E. Arvidson
C. Chapman

Fruchter, Laul, Rancitelli, Perkins
Exposure Age And Other Information On Lunar Surface Material And Meteorites From ⁵³Mn Measurements

Mörgeli, Eberhardt, Eugster, Geiss, Grögler, Jungck
The Age Of Shorty Crater

Drozd, Hohenberg, Morgan, Podosek, Wroge
Cosmic Ray Exposure History At Taurus-Littrow

Mandeville
Impact Microcraters On 12054 Rock

Fechtig, Nagel, Stähle, Schneider, Neukum, Grögler
Primary And Secondary Impact Crater Phenomena On An Apollo 12 Sample

Arvidson, Guinness, Hohenberg
On The Constancy Of The Lunar Cratering Flux Over The Past 3.3 Billion Years

Young
The Lunar Impact Flux, Radiometric Age Correlation, And Dating Of Specific Lunar Features

König, Neukum, Fechtig
Recent Lunar Cratering: Absolute Ages Of Kepler, Aristarchus, Tycho

Schultz, Greeley, Gault
Interpreting Statistics Of Small Lunar Craters

Neukum
Different Ages Of Lunar Light Plains

Ahrens, Jackson, Jeanloz
Dynamic Properties Of Ilmenite-Rich Mare Basalt And The Relative Ages Of Lunar Cratered Surfaces

Wednesday, March 16, 1977

IV- B. MAGNETIC INVESTIGATIONS; RE-INVESTIGATIONS OF ORBITAL DATA

Building 30 Auditorium
1:30 p.m.

Chairmen: A. Brecher
G. W. Pearce

- Lin, Anderson, Bush
Age Distribution Of Lunar Surface Magnetic Fields
- Cisowski, Fuller, Hale
On The Intensity Of Ancient Lunar Magnetic Fields
- Weiss, Hood, Coleman Jr.
The Cratered-Shell Model Of The Lunar Permanent Magnetic Field: Multipolar Analysis
- Srnka
Spontaneous Magnetic Field Generation In Hypervelocity Impacts
- Brecher
New Evidence For Textural Magnetization (TXM) In Lunar Rocks Synthetic Analogs And Meteorites
- Lanoix, Strangway, Pearce, Wu, Taylor
Anomalous Acquisition Of Thermoremanence At 180°C In Iron And Paleointensity Of Meteorites
- Stephenson, Runcorn, Collinson
A Preliminary Palaeointensity Result For Sample 10017
- Anderson, Bush, Lin
Magnetized Regions On The Lunar Farside Detected By Electron Reflection Techniques
- McCoy, Lin, Anderson
Magnetic Modeling Of The Rima Sirsalis Lunar Magnetic Anomaly
- Bieléfeld
Lunar Surface Chemistry Of Regions Common To The Orbital X-Ray And Gamma-Ray Experiments
- Hubbard
A Re-Examination Of The Orbital X-Ray Data From Apollo 15 And 16
- Parker, Haines, Metzger
Thorium Concentrations In The Lunar Surface
- Pratt, Moore, Parsons, Anderson
Pattern Recognition Studies On Apollos 11, 15, 16 And 17 Data
- Schonfeld
Comparative Study Of Orbital And Lunar Sample Geochemistry

Thursday, March 17, 1977

IV- C. EVOLUTION OF THE PLANETARY CRUST:
AGE OF EARLY IMPACTITES, COOLING HISTORY, KREEP,
AND EVOLUTION OF EARLY MELTS

Building 2 Auditorium
8:30 a.m.

Chairmen: J. S. Huebner
G. A. McKay

- Hinthorne, Conrad, Church
Lead-Lead Age And Rare Earth Element Determinations In Lunar Norite 78235
- Jessberger, Dominik, Kirsten, Staudacher
New ⁴⁰Ar-³⁹Ar Ages Of Apollo 16 Breccias And 4.42 AE Old Anorthosites
- Delano, Bence
4.2-4.3 AE Soil Fragments: Equilibrated Or Unequilibrated, Polycrystalline Systems?
- Takeda, Miyamoto
Inverted Pigeonites From Lunar Breccia 76255 And Pyroxene-Crystallization Trends In Lunar And Achondritic Crusts
- Nord Jr., Huebner, Ross
Structure, Composition, And Significance Of "C-P" Zones In 76535 Orthopyroxene
- Charette, Taylor, Adams, McCord
The Detection Of Fra Mauro Basalts In The Lunar Highlands By Remote Spectral Reflectance Techniques And Implications For Crustal Stratigraphy
- McKay, Weill
KREEP
- Nyquist, Wiesmann, Shih, Bansal
REE And Rb-Sr Analysis Of 15405 Quartz-Monzodiorite (Super-KREEP)
- Hollister, Crawford
Evidence For A Direct Genetic Connection Between Apollo 15 KREEP And Apollo 12 And 15 Basalts
- Irving
Chemical And Experimental Constraints On The Genesis Of Apollo 15 And Apollo 17 KREEP Basalts
- Hess, Rutherford, Campbell, Dick
Fractionation Of Lunar Feldspathic Magmas
- Dymek, Quick, Albee
The Role Of Silicate Liquid Immiscibility: Constraints From A Terrestrial Example

Lofgren, Usseiman
*Dynamic Crystallization Experiments Bearing On The Origin Of
Textures In Impact Generated Liquids*

Thursday, March 17, 1977

III-B. REGIONAL GEOLOGY AND LOCAL FEATURES

Gilruth Center, Room 104
8:30 a.m.

Chairmen: W. R. Muehlberger
R. S. Saunders

- Johnson, Mosher, Matson
Lunar Spectral Units: A Northern Hemispheric Mosaic
- Saunders, Thompson, Mosher
Characteristics Of Lunar Maria: Earth-Based Data
- Scott, Diaz, Watkins
Lunar Farside Tectonics And Volcanism
- Pieters, Adams, Bryan, Head, McCord, Zisk
*Geology And Geochemistry Of The Flamsteed Region Of Oceanus
Procellarum: A Preliminary Report Based On Remote Sensing And
Lunar Sample Information*
- Whitford-Stark, Head
Oceanus Procellarum: Volcanic And Tectonic Evolution
- Lucchitta
*Mare Ridges, Topography, And Structure In Southern Imbrium And
Northern Procellarum*
- Muehlberger
*Comparison Of Structural Style Between Northern Mare
Tranquillitatis And Southern Mare Serenitatis*
- Boyce, Schaber
*Ring-Moats On The Lunar Maria: Buried Impact Craters And Their
Implication To Crater Erosion Model*
- Hodges
*Basaltic Ring Structures Of The Columbia Plateau And Possible
'Extraterrestrial Analogs*
- Andre, Adler, Wolfe, Weidner, Philpotts
*Chemical Character Of The Partially Flooded Smythii Basin From
Al/Si Orbital X-Ray Data*
- Maxwell, Strain, El-Baz
*Analysis Of Low Altitude X-Ray Fluorescence Data From Mare
Crisium And Mare Smythii*
- Greeley, Schultz, Wilbur
Volcanic Features Of The Smythii Basin
- DeHon
*Mare Humorum And Mare Nubium: Basalt Thickness And Basin
Formation History*

Butler Jr., Morrison
Geology Of The LUNA 24 Landing Site

Thursday, March 17, 1977

VI-C. LUNAR ENVIRONMENT AND ITS PAST VARIATIONS

Gilruth Center, Room 206
8:30 a.m.

Chairmen: R. H. Becker
D. E. Brownlee

- Davie, Bull, Durrani
Charged-Particle Track And Micrometeorite-Crater Studies On Apollo 15 Green-Glass Spherules
- Goswami, Lal
Particle Track Correlation Studies In Lunar Soils: Long Term Fluctuations In Ancient Meteoritic Flux In Lunar Space
- Hartung, Breig, Comstock
Microcrater Studies On 60015 Do Not Support Time Variation Of Meteoroid Flux
- Morrison, Zinner
Microcraters And Solar Cosmic Ray Tracks
- Bhandari
Solar Flare Induced Al-26 In Short Exposure Age Rocks
- Gopalan, Goswami, Rao, Suthar, Venkatesan
Solar Cosmic Ray Produced Noble Gas Isotopes And Fossil Tracks In Lunar Soil, 14163
- Dartyge, Dran, Duraud, Langevin, Maurette
Thermal Annealing Of Nuclear Particle Tracks In Minerals And The Chemical Composition Of Very Heavy Cosmic Rays
- Reedy
Solar Proton Fluxes Since 1956
- Zinner, Walker, Chaumont, Dran
Surface Enhanced Elements And Microcraters In Lunar Rock 76215
- Fireman, DeFelice, D'Amico
Carbon-14 In Lunar Soil (Temperature-Release And Size-Fraction Study)
- Becker, Clayton
Solar Wind Nitrogen As An Indicator Of Regolith History
- Kerridge, Kaplan, Lingenfelter, Boynton
Solar Wind Nitrogen: Mechanisms For Isotopic Evolution

Thursday, March 17, 1977

III-C. PETROLOGY, GEOCHEMISTRY, AND ISOTOPIC SYSTEMATICS OF MARE BASALTS

Building 2 Auditorium
1:30 p.m.

Chairmen: T. Grove
K. Marti

- Palme, Wlotzka
Trace Element Fractionation During Crystallization Of Lunar Rock
75035
- Haskin, Jacobs, Brannon
Dispersions In REE Among Lunar And Terrestrial Basalts
- Murali, Ma, Schmitt, Warner, Keil, Taylor
Chemistry Of 30 Apollo 17 Rake Basalts; 71597 A Product Of Partial Olivine Accumulation
- Vaniman, Papike
The Apollo 17 Drill Core: Chemistry And Stratigraphy Of Monomineralic Fragments And The Discovery Of A New Very Low Ti (VLT) Mare Basalt
- Rhodes, Blanchard, Brannon, Rodgers, Dungan
Chemistry, Classification And Petrogenesis Of Apollo 12 Mare Basalts
- Dungan, Brown, Meyer
Petrography And Petrology Of Apollo 12 Ilmenite Basalts 12005 And 12045
- Nyquist, Bansal, Wooden, Wiesmann
Sr-Isotopic Constraints On The Petrogenesis Of Apollo 12 Ilmenite Basalts
- Papanastassiou, DePaolo, Tera, Wasserburg
An Isotopic Triptych On Mare Basalts: Rb-Sr, Sm-Nd, U-Pb
- Guggisberg, Eberhardt, Geiss, Grögler, Stettler, Brown, Peckett
Youngest And Oldest Mare Basalts: The Temporal Extent Of Mare Filling
- Nakamura, Unruh, Gensho, Tatsumoto
Evolution History Of Lunar Mare Basalts: Apollo 15 Samples Revisited
- Lugmair, Marti
Evolution Of The Lunar Interior: Sm-Nd Systematics Of Al₂SiO₅ Green Glass And The Question Of The Lunar Initial $^{143}\text{Nd}/^{144}\text{Nd}$
- Murthy, Coscio Jr.
Rb-Sr Isotopic Systematics And Initial Sr Considerations For Some Lunar Samples
- Schaeffer, Müller, Grove
Laser ^{39}Ar - ^{40}Ar Study Of Apollo 17 Basalts

Thursday, March 17, 1977

VII-C. INTERACTIONS OF SOLID BODIES; ORIGIN OF THE MOON

Gilruth Center, Room 104
1:30 p.m.

Chairmen: D. Gault
E. M. Shoemaker

- Freeman
A Model Of The Magnetic Field In The Solar Nebula
- Ip
Monte Carlo Simulation Of The Jet Stream
- Greenberg, Hartmann, Chapman
Orbital Resonances In The Planet-Building Process
- Hartmann
Experiments On Early Growth Of Moon And Planets
- Turcotte, Nordmann
Numerical Calculations Of The Cross Section For The Accretional Capture Of The Moon By The Earth
- Binder
Fission Origin For The Moon: Accumulating Evidence
- Friedlander, Smith
Limits To Tidal Control On Lunar Asymmetry
- Harris
The Effect Of Tidal Friction On The Origin And Thermal Evolution Of The Moon
- Ransford
The Moon's Post-Accretional Temperature Distribution
- Wetherill
Evolution Of The Earth's Planetesimal Swarm Subsequent To The Formation Of The Earth And Moon
- Malin
Early Evolution Of Planetary Surfaces
- Davis, Chapman
The Collisional Evolution Of Asteroid Compositional Classes

Thursday, March 17, 1977

II-B. LUNAR CORES: CHARACTERIZATION AND DEPOSITIONAL HISTORY

Gilruth Center, Room 206
1:30 p.m.

Chairmen: G. H. Heiken
D. Heymann

Langevin, Maurette

*Galactic Cosmic Rays Induced Isotopes, Meteoritic Gardening, And
The Deposition History Of Lunar Core Tubes*

Goswami, Borg, Langevin, Maurette, Price

*Microstratification In Apollo 15 And 16 Core Tubes: Implications
To Regolith Dynamics*

Blanford, McKay, Wood

Particle Track Densities In Double Drive Tube 60009

Crozaz, Dust

*Irradiation History Of Lunar Cores And The Accumulation Of The
Regolith*

Nagle

Possible Sources Of Immature Soil At The Apollo 16 ALSEP Site

Morris, Gose

*Ferromagnetic Resonance And Magnetic Studies Of The Apollo 16
Deep Drill Core: Surface Exposure And Compositional Stratigraphy*

Meyer, McCallister

The Apollo 16 Deep Drill Core

Heymann, Ray, Walker, Dziczkaniec, Palme

Inert Gas Stratigraphy Of The Lower Half Of The Apollo 16 Drill Core

Kohl, Russ III, Arnold, Nishiizumi, Imamura, Honda

*⁵³Mn In Lunar Cores: Evidence For The Time Scale Of Surface
Gardening*

Banerjee, Gingrich, Marvin

Remanent Magnetization Stratigraphy Of Lunar Cores

Papike, Lellis, Becker, Vaniman

*The Apollo 17 Drill Core: Modal Data (Sections 70007, 70008,
70009)*

Taylor, Keil, Warner

*Petrology Of Apollo 17 Deep Drill Core-I. Depositional History
Based On Modal Analyses Of 70009, 70008, And 70007*

Ali, Ehmann

Chemical Characterization Of Apollo 17 Deep Drill Cores 70007-70009

Friday, March 18, 1977

SUMMARY SESSION

Building 2 Auditorium
8:30 a.m.

Chairmen: M. Duke
T. McGetchin

SUMMARY ON EACH MAJOR CONFERENCE TOPIC

- I. Constraints on structure and composition of planetary interiors.
Summarizer: S. Solomon
- II. Characteristics and movements of materials on lunar, planetary
and asteroidal surfaces.
Summarizer: John B. Adams
- III. Characterization and evolution of maria and other volcanic
landforms.
Summarizer: A. E. Bence
- IV. Characterization and evolution of planetary crusts.
Summarizer: Lincoln Hollister
- V. Nature and effects of impact processes.
Summarizer: Thomas Ahrens
- VI. Extraterrestrial materials as solar/interplanetary/interstellar
probes.
Summarizer: R. Housley
- VII. Earliest history of the solar system.
Summarizer: D. S. Burnett

NEW MOONS

TOWING ASTEROIDS INTO EARTH ORBITS
FOR EXPLORATION AND EXPLOITATION

SPECIAL SESSION OF THE EIGHTH LUNAR SCIENCE CONFERENCE

16 (Wednesday) March 1977

8:00 p.m. - 10:30 p.m.

GILRUTH CENTER - Room 104

JOHNSON SPACE CENTER

THIS IS AN OPEN SESSION. ALL CONFERENCE ATTENDEES, MEMBERS OF THE JOHNSON SPACE CENTER, AND HOUSTON TECHNICAL COMMUNITY, AND THE PUBLIC ARE CORDIALLY INVITED TO ATTEND.

Two recent developments encourage immediate consideration of the possibility of bringing asteroids into orbits about the earth for exploration and exploitation:

(1) The distribution of crater sizes on the moon, Mars, Mercury, and the earth, and recent astronomical surveys indicate the possible existence of many thousands of asteroids larger than 100 meters in diameter in orbits approximately 1 AU from the sun and with velocity differences with respect to earth of ≈ 3 km/second. Retrieval of such asteroids requires 10 to 100 times less energy than for similar main belt asteroids located between Mars and Jupiter.

(2) The mass-driver, first proposed for ejecting soil pellets from the moon, can be used in space as an electric rocket engine. A mass-driver coupled to a 100 megawatt power plant (possibly a solar array) could be assembled in low earth orbit. Reaction mass necessary to propel the mass driver tug for the 3 to 9 month cruise to rendezvous with an asteroid could be obtained by pelletizing the oxygen/hydrogen tanks from the 30-50 shuttle flights necessary to lift the tug assemblies into low earth orbit. After rendezvous the tug would cruise back to earth in 3 to 5 years using approximately 80% of the asteroid as reaction mass. Conceivably, the initial venture could return 10,000,000 metric tons of material to earth orbit for less than 20¢/kilogram (vs. \$1000/kilogram - shuttle & tug launch to geosynchronous orbit) by the mid-1980's at a cost of 1 to 2 billion dollars.

Scientific results of immense importance should result from studies of virtually unlimited quantities of the materials returned. Asteroids should provide far less altered samples of early solar condensates than obtained from the moon or certainly from Mars. At long last cosmochemists can do "whole" rock analyses. Of far wider interest is the possible economic potential.

Speculative Scenario

Between mid-1977 and 1979 intense ground based and space (possibly using surveillance satellites) searches discover several > 100 meter earth-crossing asteroids with small velocity differences with respect to earth. A nuclear or solar powered tug is deployed by 1981 in the first major shuttle program and asteroid rendezvous and docking occur in mid-1982. Automatic analysis of asteroid material supplied to the mass driver allows between 1982 and 1985 design, fabrication and deployment of chemical processing equipment and manufacturing machinery. Men, machines and the asteroid rendezvous in high earth orbit in 1985. Now hollowed-out the asteroid provides raw materials for construction of space solar power stations (SSPS) of $3 \cdot 10^{12}$ watts output and simultaneously a shelter against radiation for workers. Presently, the U.S. consumes $5 \cdot 10^{11}$ watts/year and needs $6 \cdot 10^{10}$ watts/year of new electrical generating capacity. The first remotely located ground/sea stations are designed to receive very high microwave beam densities from the space platforms

in order to speed construction, lower costs and allow industrially significant production of synthetic fuels for immediate input to the U.S. tanker and pipeline networks starting in 1987 and meet all demands for new energy supplies for the U.S. by 1990. The following program and speakers do not intend to promote or justify this scenario but to explore the concept of asteroid detection, retrieval, and general scientific and economic utilization.

PROGRAM

CHAIRMEN: Prof. G. Arrhenius - University of California, San Diego
Dr. David R. Criswell - Lunar Science Institute

WELCOME Prof. G. Arrhenius

- (1) Dr. Brian J. O'Leary - Princeton University
General overview of the development, deployment, and cost of a mass driver tug and retrieval of an earth approaching asteroid.
- (2) Prof. E. M. Shoemaker - Cal. Inst. Tech./U. S. Geological Survey
Probable population of earth approaching asteroids and present and future telescopic searches.
- (3) Prof. T. B. McCord and Dr. M. Gaffey - University of Hawaii
Remote determinations of the composition of earth approaching asteroids (ground and space based systems); need for direct assay and return samples.
- (4) Dr. John C. Niehoff - Science Applications, Inc.
Return trajectories - (1) Specific example, and (2) Ease of retrieval as a function of flight time, Δv , and population distributions of the asteroids.
- (5) Prof. Henry Kolm - Massachusetts Institute of Technology
Mass drivers.
- (6) Mr. H. P. Davis - Johnson Space Center
Technological challenges of deploying the mass driver systems in low earth orbit.
- (7) Prof. J. R. Arnold - University of California, San Diego
Lunar versus asteroid resources.
- (8) Dr. David R. Criswell - Lunar Science Institute
"New Moons" - Scientific and economic values of a 1980's space program built on retrieval of earth approaching asteroids.

(Presentations 10 to 15 minutes with a Q/A session at end.)

FOR ADDITIONAL INFORMATION CONTACT:

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