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Memorandum

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FROM : MA/Apollo Program Director

SUBJECT: Minutes of the Apollo Site Selection Board Meeting, December 15, 1966

A. PURPOSE OF MEETING

The meeting was held to review the status of the Apollo site selection program. In an introduction, Dr. L. Reiffel stressed the need for a quantitative evaluation of landing safety in Apollo sites. The agenda is given in Attachment A. Attendees are listed in Attachment B.

B. LUNAR ORBITER PERFORMANCE

Capt. L. R. Scherer reviewed the accomplishments of the Lunar Orbiter program. Lunar Orbiter I obtained stereo medium resolution (about 8 meter) photography in 9 potential Apollo landing sites. Lunar Orbiter II obtained stereo medium resolution and monoscopic high resolution (about 1 meter) photography of 13 potential Apollo landing sites. In addition, the majority of the equatorial band on the back side and from 40° E longitude to 100° E longitude on the front side has been photographed at lower resolution.

C. GEOLOGIC INTERPRETATION

Mr. L. Rowan of USGS discussed the geologic interpretation of the photography. He described three major phenomena; the ejecta blanket and ray pattern surrounding impact craters, volcanic fields, and mass movement (a new process of slumping and flow of the top layer of lunar soil). Mr. Rowan's presentation was taken from the paper "Orbiter Observations of the Lunar Surface."*

D. SITE SELECTION SEQUENCE

Mr. D. B. James of Bellcomm, Inc. outlined the process of narrowing from potential sites, to candidate sites, to selected sites (Attachment C). A set of candidate sites is to be selected in February, 1967, as a guide to the Apollo Program and to indicate to the Site Selection Board the direction of analysis. Since this list of candidate sites will have to be chosen without data from Lunar Orbiter III, it will be tentative.

*AAS 66-180, presented at the AAS Symposium, "The Physics of the Moon," December 29, 1966.

INDEXING DATA
DATE 12-15-66 | ORR HQS | # | T M | PGM LEX | SUBJECT (Minutes) | SIGNATOR PHILLIPS | LOC 025-16

Mr. J. E. Eggleston (MSC/SSD) presented the list of potential sites (Set A) and the requirements on a set of candidate sites (Set B) suitable for any month of 1968 (Attachment D).

The potential sites are the primary targets for Lunar Orbiters I, II, and III (targets for Lunar Orbiter III had not been selected at the time of the meeting).

Candidate sites will be needed in a minimum of 5 lunar areas in order to meet all requirements throughout 1968.

Mr. O. E. Maynard presented the needs of ASPO for site selection and analysis products (Attachment E).

A set of not more than 12 candidate sites are needed for detailed performance investigations starting 7 or 8 months before launch. The final set of selected sites, chosen from the candidate sites, are needed 2 months before launch.

E. APPROACH PATH

Mr. O. E. Maynard of MSC/ASPO discussed the requirement for a smooth, level approach path to ensure proper operation of the guidance and control system. As a result of simulations run on approach paths selected from Lunar Orbiter I data, the constraint has been redefined; the new criterion will be less restrictive than the old criterion, except in the vicinity of high gate (see Attachment F).

Because of the complexity of the guidance and control problem, approach paths which fail the criterion may still be acceptable. In practice, the criterion will be used in targeting Lunar Orbiter, but sites will be selected primarily on the basis of landing safety. The approach paths will then be accepted or rejected on the basis of simulations run by the Guidance and Control group at MSC.

F. MSC DATA ANALYSIS

Mr. J. H. Sasser of MSC/Mapping Sciences Branch presented a review of preliminary screening of Lunar Orbiter I data,* including a priority list of 8 sites (in targets A1, A3, A7, and A9) for detailed analysis (see Attachment 6).

The overall priority for analysis is to give precedence to areas covered in high resolution by Lunar Orbiter II, then data from mission III, when available, then data from mission I, where no high resolution data are available.

*Preliminary Terrain Evaluation and Apollo Landing Site Analysis based on Lunar Orbiter I Photography, by Lunar Orbiter Photo Data Screening Group, NASA, Langley Research Center, LWP-323.

The primary method of establishing a quantitative measure of landing safety is computer analysis of magnetic tape data. This data will be combined with photogrammetric and geologic data. The system to digitize the data and store it in the computer is not yet operational. The problems are being worked on a 3-shift basis and it is hoped that the system will be operational in time to support the choice of candidate sites.

Mr. Spooner of MSC/Mapping Sciences Branch (Lockheed) discussed the problems of determining topography from monoscopic photography through photometric methods (see Attachment 4). The largest error in the photometric function lies in determining the albedo-illumination product, rather than in the shape of the photometric function. This product will be determined by a comparison of photometric and photogrammetric data.

In reviewing the photometric quality of Lunar Orbiter data, the following points were made:

1. Phosphor noise and dirt pick up increases with mission age.

2. The systematic component of "washboarding" caused by irregularities in the spacecraft line scan tube phosphor drum can be compensated for in analysis.

3. Non-systematic irregularities, including a streaking effect of unknown origin, cannot be compensated.

4. Overexposure of the medium resolution camera results in data lying outside the calibrated range of densities.

The estimated standard error in effective slope measurement is 4.7° on Mission II, reducing to 3° on Mission C, because of improved calibration.

G. DISCUSSION

1. Significance of geologic interpretation.

Mr. Rowan made the following points:

a. Crusts and lava tubes are not likely to be a problem in older marial areas such as target II P-6, but in very young areas such as found in II P-2, conditions may be quite different.

b. The Surveyor I landing in Oceanus Procellarum area exhibits more surface rocks than are found in Sinus Medii and Mare Tranquillitatis. This suggests that the area is more youthful and that the fragmented surface layer may be relatively thin.

c. Slopes in the older areas (highlands and large smoothed marial craters), which show "patterned ground" may be unstable. There could be a collapse or landslide danger.

2. Photogrammetric support of geology.

Mr. Rowan emphasized the importance of photogrammetric crater profiles in understanding the processes which formed and modified the crater.

3. Site certification.

The present objective of quantitative analysis leading to site certification is to achieve a 3% accuracy in an estimation of landing safety. Mr. Maynard asked if such a level of certification is required. Dr. Reiffel and Dr. Turnock replied that it is not required before a mission can be approved, but that it is highly desirable.

4. Number of candidate sites.

The number of sites in the candidate list will depend on whether certification quality analysis can be accomplished on at least two sites before the list is chosen. If the subjective ranking can be validated, a minimal number of sites (6 to 9) can be chosen. If such analysis cannot be performed, or does not validate the subjective ranking, a larger number of sites (about 12) will be chosen, to ensure inclusion of the best sites.

5. Astronaut training.

As a nominal objective, the astronauts will be trained to land on terrain similar to the candidate sites, but not on individual sites. However, an early focus on a small number of sites may permit such training.

6. Large scale maps.

The need for large scale maps (1:2,000) for operations and training was discussed. Specific requirements are not yet identified.

7. Optical aids in the LM.

In response to a question from Dr. Reiffel, Mr. Maynard stated that no action is being taken to provide optical aids in the Lunar Module to permit the astronauts to see the surface under the landing gear at touchdown.

8. Follow-on missions.

Mr. J. E. Eggleston proposed using the first set of candidate sites for the second landing mission as well as the first, leaving the data analysis manpower free to concentrate on new sites for the third mission.

ACTION ITEM

A list of candidate sites, with supporting analysis, is to be presented to the next SSB meeting by the MSC representatives. The meeting date has not been set.

The list of candidate sites will be re-examined when Lunar Orbiter III data becomes available.

Samuel C. Phillips
Major General, USAF

Enclosures

Distribution:

NASA HEADQUARTERS

M/Mueller
MD-P/Jones
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MAS/Thompson
MAS/Wagner
MAP/Seccomb
MAO/Holcomb
MAR/White
MAT/Day
MO/Stevenson
MT/Gray
MTL/Culbertson
S/Newell
SD/Cortright
SC/Liddel
SL/Bryson
SL/Kosofsky
SL/Milwitzky
SL/Nicks
SL/Scherer
SL/Shirey
SL/Strickland
SM/Foster
RTP/Krasnican

MANNED SPACECRAFT CENTER

AA/Gilruth
AB/Low
CA/Slayton
EA/Faget
EF/Eggleston
EF3/Dornbach
EF3/Sasser
ET/Stoney
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FA/Kraft
PA/Shea
PM/Maynard

KENNEDY SPACE CENTER

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DG/Mathews

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DIR/von Braun
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LANGLEY RESEARCH CENTER

159/Crabill
159/Taback
159/T. Young

JET PROPULSION LABORATORY

V. C. Clarke
A. Filice
H. H. Haglund
L. D. Jaffee
T. H. Thorton, Jr.
D. E. Willingham

U.S.G.S.

Rowan

LOCKHEED - MSC

D. L. Spooner

ATTACHMENT A

AGENDA

Apollo Site Selection Board

Introduction	L. Reiffel
Over-all Status-	
(a) Lunar Orbiter Performance and Data Screening Results	L. Scherer L. Rowan
(b) Site Selection Criteria	D. James
MSC Data Analysis-	MSC
(a) What have we learned from Lunar Orbiter I?	
(b) Realistic assessment of photometry as a means for achieving high resolution roughness information in time for Apollo. Presentation should include plans for eliminating or compensating for system artifacts affecting photometric results.	
(c) Revised plans for Lunar Orbiter I data reduction taking into account the lack of high resolution photography and the nonlinearity in the stereo direction.	
(d) Status of MSC computer capability for Apollo site analysis using Orbiter data (including schedules for output of results).	
(e) Recommended change in the Radar Approach Criteria to allow the site selection process to be eased and effects on prospective sites.	
MSC Site Selection Proposals	MSC/ASPO
(a) Presentation of a Set A list of potential sites to the committee.	
(b) Implementation Plan to obtain Set B Candidate Apollo sites by 1 February 1967.	
(c) Discussion of the lead times in Apollo Mission planning leading to requirements on the choice of Set C Selected Apollo landing sites for AS-504.	

OBSERVERS	ORGANIZATION
D. L. Spooner	Lockheed, Houston
D. D. Lloyd	Bellcomm
T. H. Thorton, Jr.	JPL
M. J. Krisnican	NASA/RTP
A. T. Strickland	NASA/SL
W. H. Shirey	NASA/SL
V. C. Clarke, Jr.	JPL
D. E. Willingham	JPL
A. Filice	JPL
N. L. Crabill	NASA/LO
L. D. Jaffe	JPL
H. H. Haglund	JPL

ATTACHMENT B

ASSB Meeting December 15, 1967

Attendance Sheet

MEMBERS	ORGANIZATION
E. E. Christensen	NASA Hq.
J. P. Claybourne	KSC
E. Cortright	NASA Hq.
J. M. Eggleston	MSC Space Sciences Division
O. E. Maynard	MSC/ASPO
L. Reiffel	Nasa Hq. (Secretary)
E. Stuhlinger	MSFC
OBSERVERS	
C. J. Byrne	Bellcomm, Inc.
J. D. Stevenson	NASA Hq.
R. P. Bryson	NASA/SL
J. H. Turnock	NASA Hq.
B. Milwitzky	NASA/SL
D. B. James	Bellcomm/MAS
B. T. Howard	Bellcomm/MAS
P. E. Culbertson	MTL
I. Taback	LRC/LOPO
L. Kosofsky	NASA/SL
L. Scherer	NASA/SL
T. Young	NASA/LRC/LOPO
L. Rowan	USGS
J. H. Sasser	MSC/Space Science Division

ATTACHMENT C

CRITERIA FOR SELECTION OF APOLLO LUNAR LANDING SITES

1. AREA TO BE COVERED
2. NUMBER OF SITES
3. DISTRIBUTION OF SITES
4. TIME AVAILABILITY OF SITES
5. SIZE AND CHARACTER OF SITES
6. SOIL MECHANICS AND TOPOGRAPHY AT THE TOUCHDOWN POINT
7. LANDING APPROACH PATH ROUGHNESS
8. LANDMARKS