DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
MANNED SPACECRAFT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GEOLOGIC SUMMARY

This map shows the geology of potential early Apollo landing site 5 in the lunar equatorial belt. The Maestlin G region is in Oceanus Procellarum approximately midway between the crater Kepler to the northeast and Flamsteed to the southwest. Full-Moon photographs of the area show dark mare materials and two faint rays from Kepler. Maps of the region by Titley (1968) and Carr and Titley (1969) at 1:100,000 show the regional setting of the landing site.

The mare material (unit Em) in the site is apparently younger than Imbrian age and younger than the mare material in most of the equatorial belt. The oldest features superposed on it are Eratosthenian. In the larger Maestlin G region, the mare material partially covers the flanks of two large Eratosthenian craters, including Maestlin G itself (Carr and Titley, 1969). Blocks are abundant in and around small craters, and the sufficial fragmental layer may be relatively thin. Pieces of lunar bedrock ejected around small craters should therefore be readily accessible for sampling.

The mare material in the map area appears to be the same age as that in Apollo site 4 (West and Cannon, 1969). The spectral reflectivity curve between 0.4 and 1.1 for the site is also closely similar to that for site 4 (McCord and others, 1969, p. 4386). The curve shows an enhancement in the blue portion of the spectrum (relative to a standard area in Mare Serenitatis) and is similar in this respect to the curve for Apollo landing site 2; however, the curve for site 5 differs in the near infrared from the curve for site 2 (McCord and others, 1969, p. 4387).

Of special scientific interest is the ring north of the landing site, at the northern edge of the map area. The unusual morphology and questionable genesis of this feature (unit Er), one of four in the Maestlin G region, make it worthy of investigation. The fact that its albedo is the same as that of the surrounding mare material suggests that it may be the rim of an old crater covered by mare material which has differentially compacted over the rim crest. Thus, the mare material here may have behaved more like an ignimbrite (a deposit capable of extensive differential compaction) than a lava flow. Alternatively, the ring might be an extrusive feature younger than the surrounding material, in which case rock samples from it may provide information concerning lunar differentiation history.

Several patches of ray material, part of the system of rays from Kepler, cross the area from northeast to southwest. The rays are very well developed in the larger Maestlin G region, where they consist of a coarse facies whose density of craters over 100 m in diameter is higher than that of the surrounding mare material and a fine facies whose density of craters less than 100 m in diameter is higher than that of the surroundings. Both facies have numerous faint to pronounced linear grooves approximately radial to Kepler. Only the fine facies (unit Crfk) occurs in the map area, in five somewhat indistinct patches. Within the landing site, faint grooves radial to Kepler are common on the rays; craters less than 100 m in diameter are only slightly more abundant than on surrounding materials. The rays are of interest because they may provide samples of material ejected during formation of the crater Kepler, although much of the surface texture of the rays may simply be caused by reworking of preexisting debris.

REFERENCES

Carr, M.H., and Titley, S.R., 1969, Geologic map of the Maestlin G region of the Moon [scale 1:100,000]: U.S. Geol. Survey Misc. Geol. Inv. Map I-622

McCord, T.B., Johnson, T.V., and Kieffer, H.H., 1969, Differences between proposed Apollo sites, 2, visible and infrared reflectivity evidence: Jour. Geophysical Res., v. 74, p. 4385-4388.

Titley, S.R., 1968, Preliminary geologic map of Lunar Orbiter site II-P-13 [scale 1:100,000]: U.S. Geol. Survey open-file report.

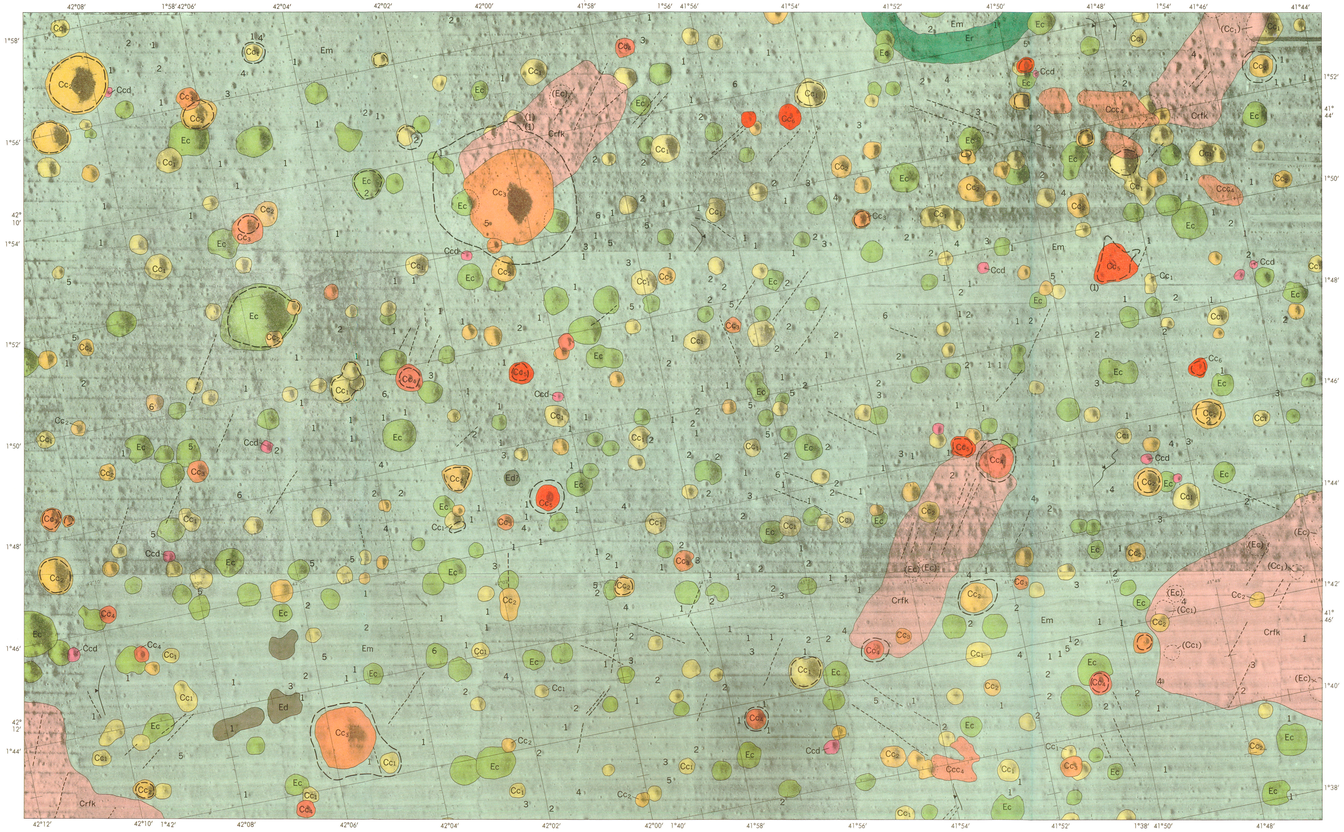
West, Mareta and Cannon, P.J., 1969, Geologic map of ellipse West Two [Apollo site 4] [scale 1:25,000]: U.S. Geol. Survey map, open-file report.

NORTH

WEST

EAST

SOUTH



Controlled base, part of ORB II-13(25), prepared by Army Map Service, Corps of Engineers, U.S. Army, Washington, D.C. 20315

SCALE 1:25000
MERCATOR PROJECTION

1 NAUTICAL MILE
1 STATUTE MILE
1 KILOMETER

Principal sources of geologic information: Lunar Orbiter moderate — resolution photographs, II-(119?-212), Lunar Orbiter high-resolution photographs, II-H198-200, H205-207, III-H165-167

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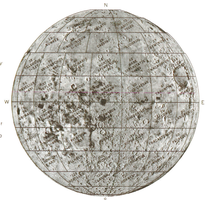
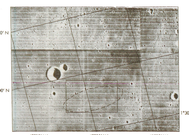
INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1969—670074



Large numbers 1-7 refer to regions that include early Apollo landing sites:
1. Maskelyne DA region - I-616
2. Sabine D region - I-618
3. Oppolzer A region - I-620
4. Mohorovičić CA region
5. Marius hills region - I-622
6. Flamsteed K region
7. Lansberg P region

Small number above quadrangle name refers to lunar base chart (LAC series)
Small number below refers to published geologic map scale 1:1,000,000

INDEX MAP OF THE EARTHSIDE HEMISPHERE OF THE MOON



PARTS OF LUNAR ORBITER II PHOTOGRAPHS OF SITE II P-13

Area of this report shown by solid line; dashed line indicates LM landing dispersion ellipse (99% landing probability). Approximate scale 1:650,000

GEOLOGIC MAP OF APOLLO LANDING SITE 5

PART OF MAESTLIN G REGION, OCEANUS PROCELLARUM

By
S. R. Titley and N. J. Trask

1969

EXPLANATION

NOTE: A crater's materials are mapped and given symbols according to the size (rim-crest diameter) and interpreted relative age of the crater. The apparent freshness of the crater on Orbiter photographs is used to determine its age, and allowance is made for an inverse relation between the sizes and rates of degradation of craters (see enclosed pamphlet). The larger craters in each age group are mapped in color (mappable materials extend relatively farther from the rim crests of young craters than from the rim crests of old craters of comparable size). The map symbols that identify these materials consist of a capital letter to designate lunar time-stratigraphic division (system), lowercase letters to designate rock unit, and, in the Copernican System, a subscript number to designate relative age of the unit. Craters in the map from becoming crowded, materials of the smallest Copernican craters are not outlined but are indicated by number only. For example, materials in unit Cc_3, outlined, and colored are associated with a relatively old Copernican crater more than 100 m (meters) in diameter; materials designated simply as are the same age but are associated with craters from 75 to 100 m in diameter. The mapping is extended to smaller size craters for younger craters than for older craters; the smallest craters in all age groups are unmapped.

COPERNICAN SYSTEM

Ccc_4 — 6

Crater material

Characteristics

Cc_6, *material of craters having well-developed bright rays. Abundant resolvable blocks (>2 meters in diameter) present. Interiors of craters have well-developed concentric fractures and terraces*

6, *material of craters having intensely bright rays. Crater rim crest very sharp and pronounced. Small craters with less well developed rays would be included in this class but confident identification is not possible*

Cc_5 — 5

Crater material

Characteristics

Cc_5, *material of craters having weakly to well developed rays. Resolvable blocks abundant in rim deposits but less numerous than for Cc_6 craters. Crater interiors have concentric fractures and terraces. Crater rim crest sharp*

5, *material of sharp-rimmed to slightly subdued-rimmed craters having bright rim deposits. Some resolvable blocks in rim deposits. Floors of most craters have concentric fractures but these are slightly subdued*

Ccc_4 — Crater cluster material

Characteristics

Material in areas having a distinctly higher density of craters 10-20 m in diameter than surroundings. Many craters are elongate northwest; many coalesce to form herringbone pattern pointing northwest. Craters strongly subdued

Interpretation

Material of secondary impact craters made by projectiles of unknown provenance

Cc_4 — 4

Crater material

Characteristics

Cc_4, *material of craters whose rim deposits appear as bright as or slightly brighter than surroundings. Abundant resolvable blocks in rim deposits of larger craters. Crater rim crest moderately to slightly subdued*

4, *material of craters whose rim deposits appear only as bright as surroundings. Only a few resolvable blocks in rim deposits. Crater rim crest moderately subdued*

Cc_3 — 3

Crater material

Characteristics

Cc_3, *material of craters whose rim deposits appear only as bright as surroundings. A few resolvable blocks in rim deposits; abundant blocks in rim deposits of largest craters; some blocks in wall material. Rim deposits in largest crater slightly brighter than surroundings. Central mound in some craters. Crater rim crest strongly to moderately subdued*

3, *material of craters having a gradual change in slope from rim crest to surrounding mare material. No resolvable blocks in rim deposits, but a few present within crater. Crater rim crest strongly subdued*

Crfk — Kepler ray material

Characteristics

Material in and around densely packed craters in elongate strips generally radial to Kepler; abundant faint to strong linear grooves, shown on map as lineaments; approximately radial to Kepler. Two facies are recognized on 1:100,000-scale map of Orbiter site II P-13 (Titley, 1968), and the conterminous Maestlin G region (Carr and Titley, 1969); the coarse facies has more craters larger than 100 m than the surroundings; the fine has more craters smaller than 100 m than the surroundings. Only the fine facies (unit Crfk) occurs in landing site 5. Craters making up the unit in this area are mostly round and in some places are only slightly more abundant than on surroundings

Interpretation

Material of secondary and tertiary impact craters formed by projectiles ejected from Kepler at low angle trajectories

Cc_2 — 2

Crater material

Characteristics

Cc_2, *material of craters having strongly subdued rim crests and interiors that range from cup shaped to flat. A few resolvable blocks in rim deposits; abundant resolvable blocks occur in interiors of large craters*

2, *material of craters having the shape of a shallow bowl. No resolvable blocks in rim deposits. Crater interior smooth. Crater rim crest rounded but raised*

Ccd — Dimple crater material

Characteristics

Material of small craters having distinctive geometry. They lack rims and their inner slopes are slightly to markedly convex upward. Except for their greater depth and the absence of blocks, they resemble small Cc_1 craters

Interpretation

Origin and significance unknown. They may be slump or collapse features or eroded impact craters

Cc_1 — 1

Crater material

Characteristics

Cc_1, *material of craters having the shape of a shallow bowl. A few resolvable blocks in the rim deposits and interiors of craters larger than 200 m. Crater rim crest strongly rounded but raised*

1, *material of craters that are gentle depressions or have the shape of a very shallow bowl*

ERATOSTHENIAN SYSTEM

Em — Mare material

Characteristics

Level cratered material making up most of the surface of the site and surrounding region. On Earth-based full-Moon photographs, unit Em is among the darkest mare units recognizable

Interpretation

Probably represents volcanic flows, the surfaces of which are covered by a fragmental layer. No layer of bedrock is positively identifiable at the general level of the surface although some may be present on the floors of craters. Mare material of this site is apparently younger than that in much of the equatorial belt; hence may be of particular interest

Ed — Dome material

Characteristics

Material of very low, irregular domes 100-400 m in diameter. Crater density same as on surroundings

Interpretation

Tumuli or volcanic pipes and vents that have been eroded to the same textural appearance as the surroundings. If domes are sources of surrounding mare material, low topographic relief indicates that ejection probably was not explosive

Er — Ring material

Characteristics

Material making up the surface of an annular ridge at north edge of map area enclosing a mare-covered floor at a slightly lower elevation. Slopes covered with patterned ground. Albedo about the same as that of unit Em

Interpretation

An old crater inundated by mare material (possibly ignimbrite) which compacted differentially to preserve the structure in subdued form. Alternatively, may be a ring-shaped extrusion, or mare material upwarped by a younger subsurface ring dike. Patterned ground on slopes caused by downhill creep of surficial debris. Of interest as it may provide information on possible ignimbrite origin of the mare material

Ec — Crater material

Characteristics

Material of strongly subdued craters. Smaller craters are gentle depressions or have the shape of shallow bowls; larger craters are pan shaped and have a distinct break in slope at rim crest. Resolvable blocks and patterned ground (irregular anastomosing ridges and troughs approximately 10 m wide and several m high) occur in wall material of larger craters

Contact
(Ec)
Buried contact
Buried unit shown in parentheses

Lineament
Shallow groove or subdued scarp

Scarp
Line marks base of slope. Barb points downslope. May be front of low volcanic flow or debris flow

Block field
Line outlines continuous or semicontinuous field of resolvable blocks. Subresolution blocks are probably abundant within line and probably extend beyond it

Interpretation of Crater Materials

Cc_6–Ec: 6–1

Materials of both primary and secondary impact craters; youngest Cc_6, oldest Ec. Ec craters and those with lower numbers are modified forms of higher numbered craters. Craters are modified through erosion by impacting micrometeorites, small meteorites, and secondary particles and by gravitative movement of loose materials caused by seismic shaking