DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

GEOLOGIC ATLAS OF THE MOON
MAESTLIN G REGION
I–622 (ORB II–13 (100))

GEOLOGIC SUMMARY

This map shows the geology in and around potential early Apollo landing site 5 in the lunar equatorial belt. The Maestlin G region is centered 9°S., 42°W. (figures 1 and 2) between the crater Kepler to the northeast and Flamsteed K to the southwest. Terra materials occur only in the northeast corner of the region. Dark mare covers the remainder, and the entire region is crossed by rays from Kepler. The geology of the region of crater Kepler, 120 km to the northeast, was mapped at a scale of 1:1,000,000 from telescopic photography (Hackman, 1962), and a 1:25,000 geologic map has been prepared of the landing site in the central part of the region (Titley and Trask, 1969).

The oldest materials in the region occur in the northeast corner, where cratered terra plains-forming materials (Itp) abut a ridge of crater rim material (pIc). The ridge is a remnant of the rim of an old crater that predates development of both mare and terra plains units. The terra plains units (Itp and Ep) occupy the floor of the old crater and are slightly higher than the adjacent mare.

Mare material within the region is generally uniform in appearance, and the dominant mare type is designated "young mare" (Em). However, a small area of more heavily cratered mare in the southeast corner of the region is called "old mare" (Im). The young mare appears to be younger than the mare of most other areas of the lunar equatorial belt. It has a slightly lower albedo, has fewer craters more than 200 m in diameter, and partly covers the flanks of two fresh-appearing craters in the west-central part of the region—Maestlin G and the 6 km crater directly to the southwest. Most mare units are Eratosthenian in age; thus, the mare is no older than Eratosthenian.

In the southeast part of the region are two faint structural features: a north-south lineament, and a subparallel, sinuous east-west scarp. Of several possible explanations, two separate mare materials with slightly different albedos. The linear depression may be the remnant of an old sinuous rille. Alternatively, both features may be related and may mark the edge of a flow front that has been largely destroyed by erosion.

Rays from Kepler cross the region from northeast to southwest and rapidly fade preexisting terrain. The rays have been divided into two units: coarsely cratered Kepler ray (Crrk) and finely cratered Kepler ray (Crfk). The coarsely cratered ray material has significantly more craters in the 100-600 m size range than the surrounding materials. The finely cratered ray has significantly more numerous within the finely cratered ray unit than in surrounding materials. Both types of rays are characterized by linear depressions approximately radial to Kepler, but the linear pattern is more striking in the finely cratered ray. The lineations are mostly secondary craters from Kepler and are generally less than 200 m wide. Some material from Kepler may be present along the rays, but the distinctive features of the rays probably result largely from reworking of preexisting mare material.

Several fault ring structures are of special interest. Each consists of a low circular ridge (unit Er) with gentle slopes enclosing an area that is commonly slightly lower than the surrounding mare. The rings may be pre-mare craters thinly covered by mare material, or they may be igneous intrusions similar to ring dikes.

Very few large scale linear structures are present in the region. In addition to those in the southeast part of the region, a north-west-trending mare ridge (unit Emr) occurs in the southwest corner. In the northeast corner the boundary between the mare and terra plains-forming units also trends north-west. Small linear rilles (unit Ec) and small faint linear grooves trending northwest and northeast are visible in much of the mare; many of the northeast-trending grooves may be secondary craters from Kepler, but some although indistinguishable, are probably structurally controlled.

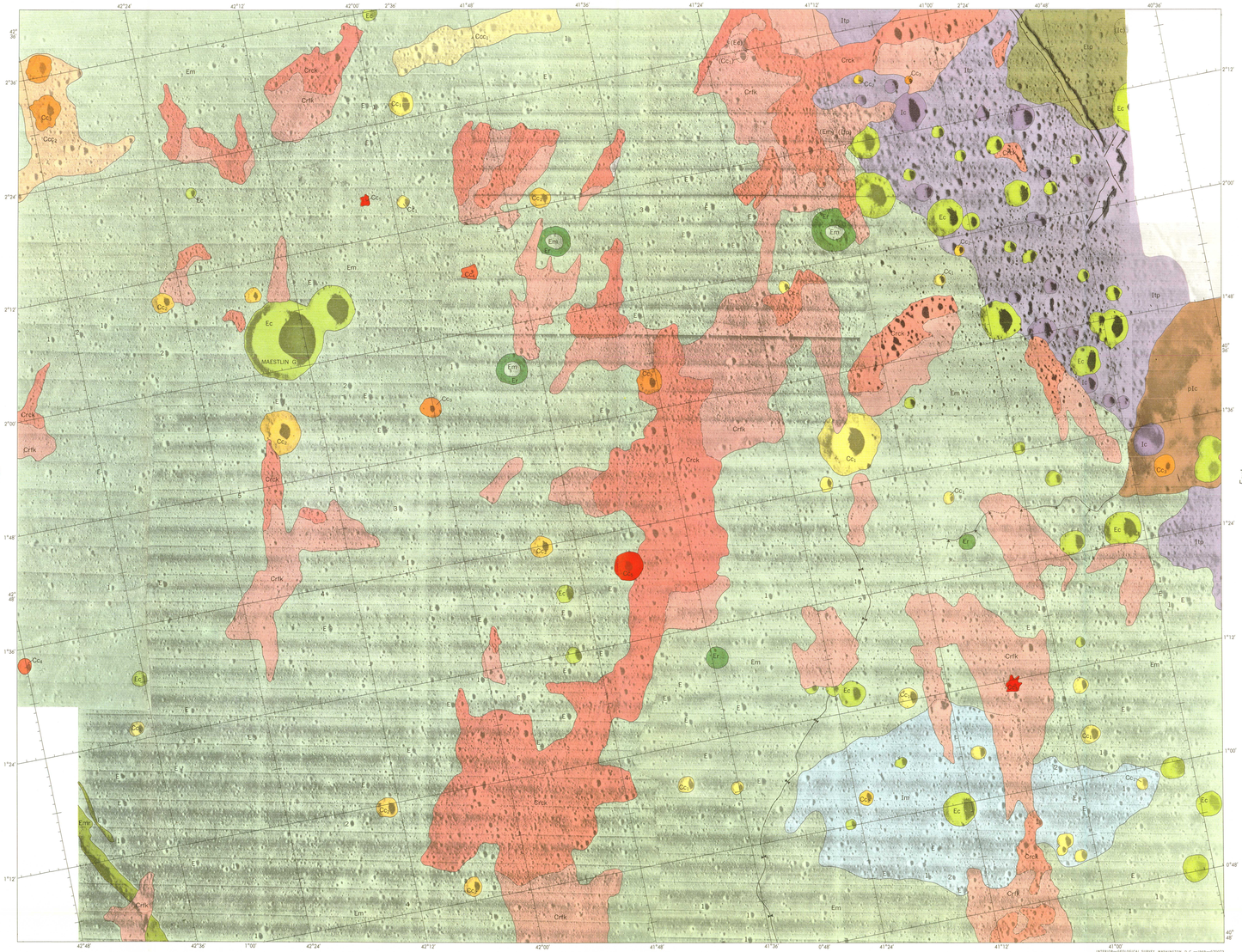
Two aspects of the region are of scientific interest. Because most of the mare material is young, the surface debris layer must be relatively thin and blocks should be plentiful around small fresh craters. It should be relatively easy, therefore, to sample bedrock underlying the debris layer. Also, the region is relatively rough, and the ring structures may all be volcanic features that formed by the same volcanic processes that deposited the mare material. The rays are of interest in that material from Kepler may be identifiable in the ray areas and would provide a sample of the deep crust. Analysis of the bulk composition of the mare material and terra plains-forming material could demonstrate whether the differences between these units result from age, composition, or lithology.

REFERENCES

Hackman, R.H., 1962, Geologic map of the Kepler region of the Moon: Geol. Survey I-1,000,000: U.S. Geol. Survey Misc. Geol. Inv. Map I-355.

Pohn, H.A., and Wilcox, R.L., 1969, A photoelectric-photographic study of the normal albedo of the Moon: U.S. Geol. Survey Prof. Paper 599-E, 24 p.

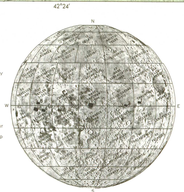
Titley, S.R., and Trask, N.J., 1969, Geologic map of Apollo landing sites: scale 1:25,000: U.S. Geol. Survey Misc. Geol. Inv. Map I-625



Controlled base is photomap Orb II-13 (100) prepared by Army Map Service, Corps of Engineers, U.S. Army, Washington, D.C. 20315

Large numbers 1-7 refer to regions that include early Apollo landing sites:
1. Descartes A region - I-616
2. Sabine D region - I-618
3. Oppolzer A region - I-620
4. Alphonsus region
5. Maestlin G region—this report
6. Flamsteed K region
7. Lansberg P region

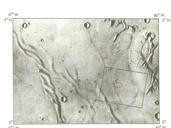
Small number above quadrangle name refers to lunar base chart (LAC series).
Small number below refers to published geologic map scale 1:1,000,000.



INDEX MAP OF THE EARTHSIDE HEMISPHERE OF THE MOON

SCALE 1:100,000
MERCATOR PROJECTION

1 ½ 0 1 2 3 4 5 6 NAUTICAL MILES
1 ½ 0 1 2 3 4 5 6 STATUTE MILES
1.5 0 1 2 3 4 5 6 KILOMETERS



MAP OF PART OF THE MAESTLIN QUADRANGLE OF THE MOON (AIC SERIES)

Area of this report shown by solid line; dashed line indicates LM landing dispersion ellipse (95% landing probability). Approximate scale 1:2,100,000.

Principal sources of geologic information: Lunar Orbiter moderate-resolution photographs: II-M197-212; III-M161. Lunar Orbiter high-resolution photograph: IV-H144; albedo data from Pohn and Wilcox (1969) and from full-Moon plates 5818 and 5819 taken at U.S. Naval Observatory, Flagstaff, Ariz.

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GEOLOGIC MAP OF THE MAESTLIN G REGION OF THE MOON

LUNAR ORBITER SITE II P–13, OCEANUS PROCELLARUM
INCLUDING APOLLO LANDING SITE 5

By
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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 the effects of factors such as 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 craters of intermediate or old age, so the ease of identification of 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 within the system. Thus, Cc$_1$ designates Copernican crater materials of the smaller craters in each age group are not outlined; such craters are indicated by number or letter symbol only. For example, materials designated Cc$_1$, outlined and colored, are associated with a relatively old Copernican crater more than 60 km in diameter. Materials of craters designated simply 1 are the same age but are associated with craters from 400 to 600 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.

Crck Crfk
Kepler ray materials

Characteristics
Materials in and around deeply cratered areas of mare and terra. Faint to strong linear grooves occur approximately radial to Kepler. Albedo higher than that of unit Crfk, mostly.
Crck, material of coarsely cratered ray. More craters larger than 200 m in diameter compared to surrounding terrain. Many craters occur in chains radial to Kepler or overlap or form grooves. Some craters are elongate but many are circular and resemble secondary craters.
Crfk, material of finely cratered ray. Surface almost completely saturated with craters smaller than 200 m but density of larger craters is comparable to surveyed terrain. Craters occur in chains or overlap to form fine lineations on the surface. Albedo slightly lower than that of unit Crck. Commonly Crfk occurs adjacent to patches of Crck on the northwest side away from Kepler.

Interpretation
Mare and terra material modified by craters formed by ejecta ejected from Kepler. Surface materials mostly are reworked preexisting debris. Some ejecta material from Kepler may be present. Age equivalent to Cc$_2$ craters

Emr
Mare ridge material

Characteristics
Material forming the mare ridges in the northwest corner of the region

Interpretation
Site of volcanic intrusion or extrusion. Position of ridge controlled by subsurface structure. May also be some form of pressure ridge

Em
Young mare material

Characteristics
Most extensive unit in the region. Forms nearly level surface. Intensely darker on Earth-based telescopic photographs than mare units surrounding the site

Interpretation
Probably composed of volcanic flows, the surfaces of which are covered by a fragmental layer. No bedrock is positively identifiable on the surface, although some may be present in the walls of young craters. Age is Eratosthenian because of the surface and the fact that material occurs on the flanks of large Eratosthenian craters such as Maestlin. In the stratigraphic part of the region suggest an age at least as young as Eratosthenian and the presence of Eratosthenian craters on the surface reinforces the age to Eratosthenian

Im
Old mare material

Characteristics
Occurs in the southeast corner of the region. Resembles young mare material (Em) except that it is more densely cratered and has a slightly higher albedo

Interpretation
Probably volcanic flows similar to young mare material but has more craters and a thicker debris layer because of the older age. May be merely young mare material modified by ray material, but lacks lineaments typical of rays

Etp
Smooth terra plains-forming material

Characteristics
Occurs within an old large crater in the northeast part of the region. Forms generally level terrain having intermediate albedo. Fewer craters > 400 m than on Itp. Most craters are very subdued and flat floored. Fewer small (<200 m) steep craters than on the mare. Because of the high density of subdued craters, no age designation is given to craters too small to be outlined

Interpretation
Probably composed largely of fragmental debris of both volcanic and impact origin. Lack of small fresh-appearing craters and lack of blocks suggests that a much thicker surficial fragmental layer has developed on this unit than on the mare

Itp
Cratered terra plains-forming material

Characteristics
Forms highly cratered generally level terrain in floor of large old crater in northeast corner of region. Surface is saturated with subdued 200-500 m craters. Few fresh blocky craters present. Has slightly higher elevation than the mare. Albedo intermediate. Because of the high crater density, no age designation is given to craters too small to be outlined

Interpretation
Similar to unit Etp but older and more cratered. Probably composed largely of fragmental debris of both volcanic and impact origin. Lack of small fresh blocky craters suggests that much thicker surficial fragmental layer has developed on this unit than on the mare

pIc
Crater rim material

Characteristics
Forms part of the rim of an old crater 40 km in diameter that lies mostly outside the map area. Rugged, sparsely cratered terrain covered with patterned ground

Interpretation
Rim and wall of a very old crater. Subdued by mass-wasting, faulting, and micrometeorite bombardment

Contact
Dashed where two facies of same unit are separated

(Itp)
(Em)
Buried contact
Buried unit indicated by symbol in parentheses

Probable fault
Bar and ball on apparent downthrown side

Gentle sinuous scarp
Dotted where buried. Line marks base of slope and arrows point downslope. Probably a degraded flow front

Gentle linear depression
May be buried sinuous rille or may mark edge of flow front

Crater material

Cc$_5$ | 5

Characteristics
Cc$_5$, material of rayed craters having block-strewn hummocky rims; abundant blocks and terraces on wall. Faint concentric ridges on rim. Crater rim crest sharp. Rim crest moderately to strongly subdued
5, material of crater with well-developed rays. Abundant blocks on rim and within crater. Terraces on wall. Rim crest sharp.

Cc$_4$ | 4

Characteristics
Cc$_4$, material of rayed crater having block-strewn faintly hummocky rims. Abundant blocks and terraces on wall. Crater rim crest sharp
4, material of craters with bright halos and few or no rays. Abundant blocks on rim and within craters. Terraces on wall. Rim crest slightly subdued

Cc$_3$ | 3

Characteristics
Cc$_3$, material of craters with limited rays and block-strewn rims. Abundant blocks and terraces on wall. Crater rim crest slightly subdued
3, material of craters having smooth rims. Scattered blocks on rim and within craters. Rim crest moderately subdued

Ccc$_2$ | 2

Crater-cluster material

Characteristics
Material associated with cluster of Cc$_2$ craters. Cluster resembles subdued Kepler ray material but lacks the linear structures and contains small craters characteristic of the rays

Interpretation
Cluster of impact craters secondary to some crater approximately the same age as Kepler.

Ccc$_1$ | 1

Crater-cluster material

Characteristics
Material associated with cluster of Cc$_1$ craters. Most craters are larger than 100 m. Unit occurs only at the northern boundary of the region

Interpretation
Secondary impact craters

Cc$_2$ | 2

Crater material

Characteristics
Cc$_2$, material of craters having rays and block-strewn smooth rims. Blocks and subdued terraces on wall. Crater rim crest moderately subdued
2, material of craters having smooth low rims. Scattered blocks on rim and within craters. Rim crest moderately to strongly subdued

Cc$_1$ | 1

Crater material

Characteristics
Cc$_1$, material of rayless craters having smooth rims. Scattered blocks on rim and wall. Faint terraces on wall. Crater rim crest strongly subdued
1, material of rayless craters having smooth rims. Scattered blocks on rim and wall. No terraces on wall. Crater rim crest strongly subdued and rounded

Ec | E

Crater material

Characteristics
Ec, material of rayless craters having smooth rims. Scattered blocks present on rim and wall. No terraces on wall. Crater rim crests moderately to strongly subdued and rounded
E, material of shallow rayless craters having smooth rims. Few blocks on rims and wall. Few subdued blocks on rim or wall of others. Crater rim rounded and strongly subdued and barely stands above surrounding terrain

Ic

Crater material

Characteristics
Material of shallow bowl-shaped or pan-shaped craters having smooth low rims. No blocks in either rim or wall materials. Crater rim crest rounded

Interpretation of Crater Materials
Cc$_5$ - Ic 5 - E

Materials of craters that are probably mostly of impact origin. A few may be of volcanic origin. Numbers and letters designating craters are assigned numbers or letters according to relative age. Numbered craters are the youngest and the higher the number the younger the crater. Interior slopes of youngest craters are probably fragmental and brecciated debris which may include blocks of solid rock, impact melt, shock-lithified breccia fragments and gyrocakstein. Highly shocked bedrock may also be exposed in youngest craters. Material around older craters is indistinguishable from surrounding materials

COPERNICAN SYSTEM
ERATOSTHENIAN SYSTEM
IMBRIAN SYSTEM
PRE-IMBRIAN

For sale by U.S. Geological Survey, price $1.00
Explanatory pamphlet accompanies map