DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
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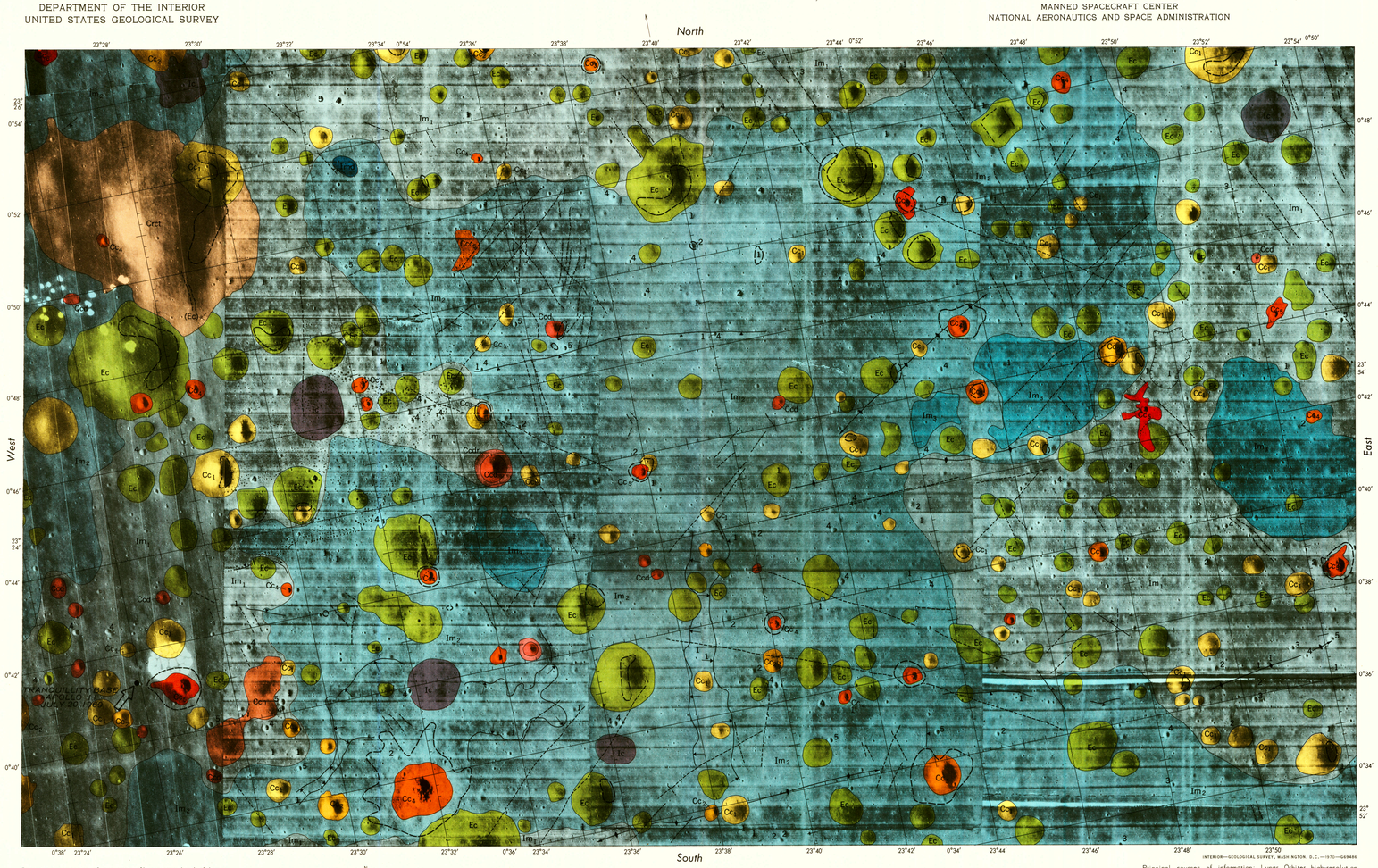
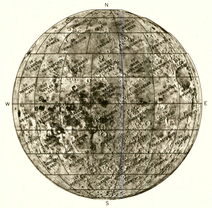


Base is a composite of two parts: 1) a narrow band of Lunar Orbiter high-resolution photograph V-H72 on the west, and 2) part of Photomap ORB II-6 (25) prepared by Army Map Service, Corps of Engineers, U.S. Army, Washington, D.C. 20315 over the rest of the map area. Irregular spots and streaks are photographic artifacts

Large numbers 1-7 refer to regions that include early Apollo landing sites:

1. Maskelyne DA region
2. Sabine D region
3. Oppolzer A region
4. Wichmann CA region
5. Maestlin G region
6. Lansberg B region
7. Lansberg P region

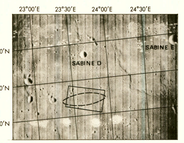
Small number above quadrangle name refers to lunar base chart (LAC series);
Small number below refers to published geologic map (scale 1:1,000,000)



INDEX MAP OF THE EARTHSIDE HEMISPHERE OF THE MOON

MERCATOR PROJECTION
Scale 1:25000

1 ½ 0 1 NAUTICAL MILE
1 .5 0 1 STATUTE MILE
1 .5 0 1 KILOMETER



PART OF LUNAR ORBITER PHOTOGRAPH V-M73

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

GEOLOGIC MAP OF APOLLO LANDING SITE 2 (APOLLO 11)

PART OF SABINE D REGION, SOUTHWESTERN MARE TRANQUILLITATIS

By
Maurice J. Grolier
1970

Principal sources of information: Lunar Orbiter high-resolution photographs II-H84 (2, 3 of 3), II-H85 (2, 3 of 3), II-H86 (2, 3 of 3), V-H71, H72, H75 and H76

Work performed on behalf of the National Aeronautics and Space Administration under contract No. T-66353G

LUNAR SURFACE MATERIAL

This map shows the geology of the region where Apollo 11 landed on July 20, 1969 (arrow in lower left corner of map). The site is approximately 20 km south of the crater Sabine D, in the west-central part of the Sabine D region, in southwestern Mare Tranquillitatis (Grolier, 1970).

The surface material at the spot where Apollo 11 touched down consists of fragmental material, generally fine grained but with abundant rocks up to 1 meter in diameter. The fine-grained material is notable in containing abundant glass. The rocks are fine-grained vesicular basaltic lavas, medium-grained vuggy microgabbros, and breccias. Preliminary examination of the samples at the Lunar Receiving Laboratory of the Manned Spacecraft Center indicates a basaltic composition, though with numerous differences in detail from any terrestrial or meteoritic samples previously available for analysis (Lunar Sample Prelim. Exam. Team, 1969). Several rocks have yielded ages of 3.6 ± 0.7 x 10^9 years by the potassium-argon method.

The composition of the surficial material at the Surveyor V landing site, approximately 25 km to the northwest, had previously been interpreted to be basaltic (Turkevich and others, 1967, p. 637; Gault and others, 1967, p. 641). Moreover, in the southwestern part of Apollo landing site 2, mare unit Im_2 is hummocky in places and has a multilobate outline suggestive of some terrestrial volcanic flows. The spectral reflectivity curve (0.4 μ to 1.1 μ) for the site shows a higher reflectivity in the blue wavelengths, relative to a standard point in Mare Serenitatis, than the curves for other early Apollo landing sites (McCord and others, 1969, p. 4386) and is similar to the curve for other parts of Mare Tranquillitatis (McCord, 1969). These observations suggest that the composition of the mare material in this landing site may differ from that of mare material in the other early Apollo sites.

REFERENCES

Gault, D.E., Adams, J.B., Collins, R.J., Green, Jack, Kuiper, G.P., Masursky, Harold, O'Keefe, J.A., Phinney, R.A., and Shoemaker, E.M., 1967, Surveyor V—Discussion of chemical analysis: Science, v. 158, no. 3801, p. 641-642.

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McCord, T.B., 1969, Color differences on the lunar surface: Jour. Geophys. Research, v. 74, p. 3131-3142.

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Turkevich, A.L., Franzgrote, E.J., and Patterson, J.H., 1967, Chemical analysis of the Moon at the Surveyor 5 landing site: Science, v. 158, no. 3801, p. 635-637.

EXPLANATION

NOTE: A crater's materials are mapped 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), lower case letters to designate rock unit, and, in the Copernican System, a subscript number to designate relative age within that system. To keep the map from becoming crowded, materials of the smaller Copernican craters are not outlined but are indicated by a number only. For example, materials mapped as Cc_1, outlined, and colored are associated with a relatively old Copernican crater more than 100 m (meters) in diameter; materials designated simply 1 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_5

Crater cluster material

Characteristics
Material of small rayless 3-30 m craters, occurring in one irregular cluster in the northwestern part of the map
Interpretation
Material of small secondary impact craters; composed mainly of reworked surficial fragmental layer. Origin of projectiles unknown

Ccd | Ccdr

Dimple crater material

Characteristics
Ccd, *undivided. Material of nearly rimless craters having convex upward walls*
Ccdr, *dimple crater rim material. Forms poorly defined rim about one fourth crater diameter wide. Rim crest rounded*
Interpretation
Material of small volcanic vents or of impact craters in which the fragmental layer has drained through narrow fractures or openings into the underlying substrate. Sublimates may occur around the rims

Cch

Material of irregular chain crater

Characteristics
Material of subdued shallow craters (generally >125 m) aligned north-eastward. Blocks larger than 2 m absent. Patterned ground conspicuous
Interpretation
Probably material of secondary impact craters

Crct

Theophilus ray cluster material

Characteristics
Material in and around cluster of subdued craters in northwest corner of map area. Patterned ground well developed. Some blocks present along the rim crest
Interpretation
Material of secondary impact crater formed by ejecta from the crater Theophilus. May contain rock fragments derived from Theophilus, 320 km to the southeast

Cc_5

Crater material

Characteristics
Material of crater having well-developed light and dark rays. A few resolvable (>2 m) blocks in rim deposits. Concentric structure occurs in wall material. Crater rim crest very sharp

Cc_5 | 5

Crater material

Characteristics
Cc_5, *material of craters having bright ray material. Abundant blocks present in rim deposits. Floor material hummocky. Crater rim crest sharp to slightly subdued*
5, *material of slightly subdued craters. Short bright rays extend away from some craters. Blocks are few or lacking. Floor material hummocky*

Cc_4 | 4

Crater material

Characteristics
Cc_4, *material of moderately subdued craters without rays. Only a few blocks in rim deposits. Craters as large as 400 m have a few rays and abundant blocks in rim deposits and on adjacent mare material. Crater rim crest moderately subdued*
4, *material of moderately to strongly subdued craters without rays. Few or no blocks present in rim deposits. Floor material hummocky*

Cc_3 | 3

Crater material

Characteristics
Cc_3, *material of moderately to strongly subdued craters. A few blocks in wall and rim material*
3, *material of strongly subdued craters. No blocks present in rim and wall material*

Cc_2 | 2

Crater material

Characteristics
Cc_2, *material of strongly subdued craters having a few blocks in rim and wall material*
2, *material of craters having the shape of a shallow bowl. No blocks present*

Cc_1 | 1

Crater material

Characteristics
Cc_1, *material of gentle depressions, bowl- or pan-shaped craters, and strongly subdued craters. Some blocks present in rim and the upper part of wall. Patterned ground (irregular, subparallel, anastomosing ridges and troughs, several meters high and approximately 10 m wide) well developed*
1, *material of bowl-shaped craters or gentle depressions. No blocks present. Patterned ground not conspicuous probably because of small size of craters*

Interpretation of Copernican Crater Material
Cc_5-Cc_1: 5-1
Poorly sorted fragments in and around primary and secondary impact craters; as in deposits of terrestrial impact craters, only a small percentage of the fragments are likely to be shock compressed or to contain high-pressure and high-temperature minerals resulting from shock. Morphology of craters is progressively modified with increasing age by mass wasting, tectonism, and superposition of craters and ejecta (Cc_5: 1, oldest; Cc_5, youngest)

ERATOSTHENIAN SYSTEM

Ec

Crater material

Characteristics
Material of gentle depressions, pan-shaped and shallow bowl-shaped craters, and strongly subdued 125-400 m craters. Some blocks are present on the rim crest of some strongly subdued 350 m craters. Patterned ground well developed
Interpretation
Material of old impact craters modified by lunar erosion processes including further fragmentation by later impact. Rock fragments within Eratosthenian craters probably are of smaller mean size than in Copernican craters

IMBRIAN SYSTEM

Imd

Mare dome material

Characteristics
Material of elongate dome about 200 m in diameter and elongated to the northwest in northwest part of map. The material forms a slight bulge in the surface of mare unit Im_2 and apparently is not directly related to a linear mare ridge
Interpretation
Material of small volcanic plug mantled with surficial fragmental layer

Im_3
Im_2
Im_1

Mare material

Characteristics
Forms gently rolling to level, moderately cratered mare surface. Density of large subdued pan-shaped craters (>500 m) higher than in the potential Apollo sites in the western part of the Moon. Relatively few subdued craters (50-125 m) compared to western sites
Im_1, *appears slightly darker than Im_2 and Im_3. Occurs only in four small areas that appear slightly depressed with respect to the surrounding terrain. Density of craters (>50 m) lower than in Im_2 and Im_3. Im_1 is included in unit Im_2 on the geologic map of the Sabine D region at the 1:100,000 scale (Grolier, 1970)*
Im_2, *appears slightly darker than Im_3. Density of large subdued craters (500-700 m) lower than on Im_3 in the larger Sabine D region (Grolier, 1970). Craters >125 m cover about 10 percent of unit. In southwestern part of the map area, the surface of the unit is hummocky, and locally includes low lobate scarps.*
Im_3, *appears slightly brighter than Im_2. Craters >125 m cover about 15 percent of unit*
Interpretation
Probably consists of basaltic flows or ash-flow tuffs; vesicular volcanic ash (or lapilli) derived from volcanic vents (such as unit Ccd) may also be present. Uppermost flows are deeply cratered, and mantled by a fragmental layer

Ic

Crater material

Characteristics
Materials of pan-shaped 400-600 m craters. Blocks lacking. Patterned ground well developed. Crater rim crests extremely subdued
Interpretation
Materials of very old impact craters. Composition of the surficial fragmental layer around these craters may be different from that around younger craters if rock fragments are lithologically heterogeneous and have different disintegration rates, so that only certain rock types are preserved

Contact
Dashed where approximately located

(Ec)
Buried contact
Dots show limit of buried unit where topographically expressed. Buried unit indicated by symbol in parentheses

Lineament
Very gentle scarp or gentle narrow trough

Scarp
Barbs point downslope. May be fault or flow front

Gentle sinuous scarp
Arrow points downslope. May be a flow front

Low linear ridge

Irregular depression
Probably collapse feature or possibly graben

Block field
Area where blocks larger than 2 m. in diameter are abundant

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Moon (Apollo 11: landing site 2). Geol. 1:25,000. 1970.
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For sale by U.S. Geological Survey, price $1.00
Explanatory pamphlet accompanies map

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