DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
JET PROPULSION LABORATORY, CALIFORNIA INSTITUTE OF TECHNOLOGY
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AND THE
USAF AERONAUTICAL CHART AND INFORMATION CENTER

GEOLOGIC ATLAS OF THE MOON
BONPLAND H REGION
I-693 (RLC-3)

NOTES ON BASE

The base chart was produced by ACIC in consultation with Dr. Gerard P. Kuiper and the staff of the Lunar and Planetary Laboratory, University of Arizona.

CONTROL

The lunar features on this chart are positioned to conform with the selenographic latitude and longitude coordinates based on the selenographic control as compiled by D. W. G. Arthur and E. A. Whitaker in the Orthographic Atlas of the Moon, edited by Dr. Gerard P. Kuiper, 1960. The position of the impact point is provisional since it was located in respect to surrounding features.

NAMES

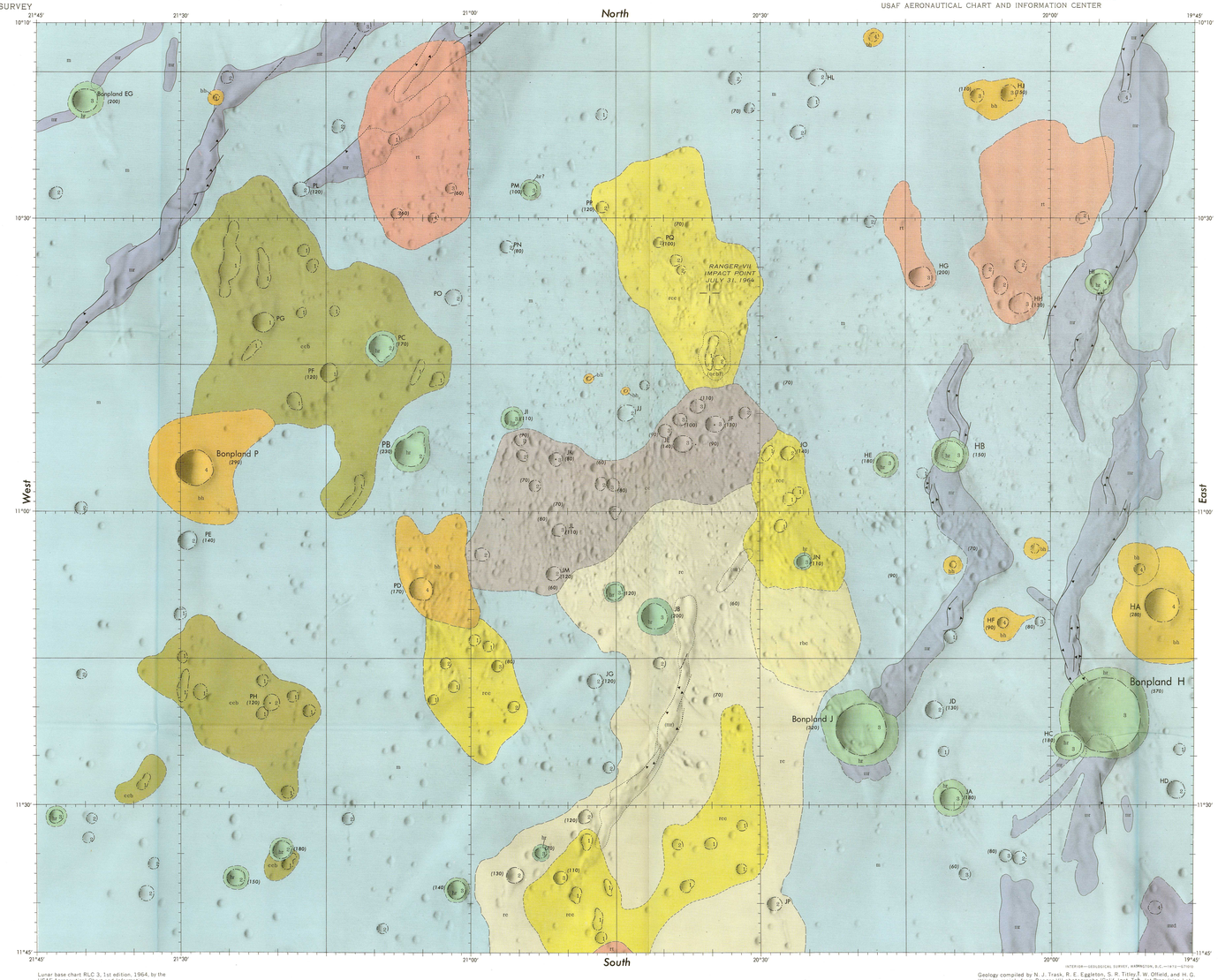
Feature names are adopted from the 1935 International Astronomical Union nomenclature system as amended by Commission 16 of the I.A.U., 1961 and 1964. Supplementary features are associated with the named features through the addition of identifying letters. Craters are identified by capital letters.
A black dot is included, where necessary, to identify the exact feature named.

ELEVATIONS

The depths of craters were determined by the shadow-measuring technique, utilizing Ranger VII photography. Depths are shown in meters.
Depth of crater (rim to floor) . . . . . (200)

PORTRAYAL

The configuration of the relief features shown on the base chart is interpreted from Ranger VII television records with the exception of the low ridges. They have been added through visual observations made with the 24" Lowell Observatory refracting telescope, Flagstaff, Arizona, and the use of telescope photography. The pictorial portrayal of relief forms is developed using an assumed light source from the west, with the angle of illumination maintained equal to the angle of slope of the features portrayed. Cast shadows are eliminated to enable complete interpretation of relief forms.



Lunar base chart RLC 3, 1st edition, 1964, by the USAF Aeronautical Chart and Information Center, St. Louis, Missouri 63118

SCALE 1:100 000
MERCATOR PROJECTION
0 2 4 5 STATUTE MILES
0 2 4 5 KILOMETERS

Geology compiled by N. J. Trask, R. E. Eggleton, S. R. Titley, F. W. Offield, and H. G. Wilshire mainly from Ranger VII photographs (Calif. Inst. Tech. Jet Propulsion Lab., 1964, 1965). Ridges mapped largely from Lunar Orbiter II photographs H-120, H-125. Albedo data from inset map (see text). Work performed under contract WO-5171, Jet Propulsion Laboratory

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GEOLOGIC MAP OF THE BONPLAND H REGION OF THE MOON

1971

EXPLANATION

bh — Bright-halo crater material

Characteristics
Occurs in and around circular craters having high rims and sharp shadows. Albedo of halo greater than 0.096; albedo of crater walls approximates 0.129
Interpretation
Debris from young impact craters

rt — Tycho ray material

Characteristics
Albedo higher than that of surroundings; mostly between 0.094 and 0.100. Distinct patches radial to Tycho; single or clustered craters at south edge of patches
Interpretation
Ray material from Tycho including plumes from secondary impact craters produced by ejecta from Tycho

rc **rbc** **rcc** — Copernicus ray materials and ray cluster material

Characteristics
Bright plumes and clusters of subdued craters approximately radial to Copernicus
rc, ray. Albedo 0.093 to 0.096. No apparent topographic relief
rbc, bright ray. Albedo 0.096 to 0.100. No apparent topographic relief
rcc, crater cluster. Craters circular to elongate. Albedo mostly between 0.092 and 0.096, generally higher than that of ccb
Interpretation
Ejecta and secondary impact craters from Copernicus

ccb — Bullialdus crater cluster material

Characteristics
Higher density of circular and elongate subdued craters than surroundings; craters and strings of craters elongate radial to Bullialdus. Generally relatively dark-appearing (albedo between 0.091 and 0.094 where measured)
Interpretation
Material of secondary impact craters and debris from large primary crater Bullialdus

mr **md** — Mare ridge materials

Characteristics
mr, mare ridge materials, undivided. Similar to lunar. Albedo generally the same as that of the surrounding mare. Higher and sharper parts shown by scarp symbol. Ridges appear to crosscut rim and floor of some craters such as Bonpland HB but to be subdued by rim material of these craters
md, dark mare ridge material). Albedo 0.083 to 0.086. To south of map area forms complex of cones, mesas, sharp hills, and ridges (Bonpland G)
Interpretation
mr, volcanic extrusions overlying dikes, faulted in places where scarps are especially sharp. Ridges interpreted as older than craters such as Bonpland HB; ridges extend across rim because ejecta from crater has slumped off of them. Ridge crossing floor of Bonpland HB was a subsurface dike before formation of the crater
md, volcanic-extrusions and low pyroclastic cone materials

m — Mare material

Characteristics
Material of mare surfaces. Albedo between 0.087 and 0.093. Locally very smooth having few craters; generally has low albedo where smooth
Interpretation
Volcanic flows stirred and comminuted by micrometeorite impacts

hr — High-rimmed crater material

Characteristics
Craters have high well-developed rims but no bright halos. Albedo of rim material not resolved; probably similar to that of adjacent mare. Albedo of crater walls, where resolved (in craters 1 to 2 km in diameters), from 0.098 to 0.109
Interpretation
Material of impact craters. Halos and ejecta may have been originally present and darkened by radiation or eroded by subsequent smaller impacts

ec — Crater cluster material

Characteristics
Large circular craters, sharp to moderately subdued, approximately 0.5 to 1 km across, and abundant small circular craters, sharp to strongly subdued. Intercrater areas brighter than surrounding materials. Albedo mainly 0.094 to 0.102. Cluster is concave toward the north and includes some shallow craters elongate north-south
Interpretation
Material of secondary impact craters; sources of projectiles not known, probably from both Tycho and Copernicus

Contact
Long dashed where approximately located; short dashed where gradational

(ca) Concealed contact
Buried unit shown by symbol in parentheses

Lineament
Subdued scarp or depression

Scarp
Dotted where buried. Barb points downslope. Probably fault on mare ridge

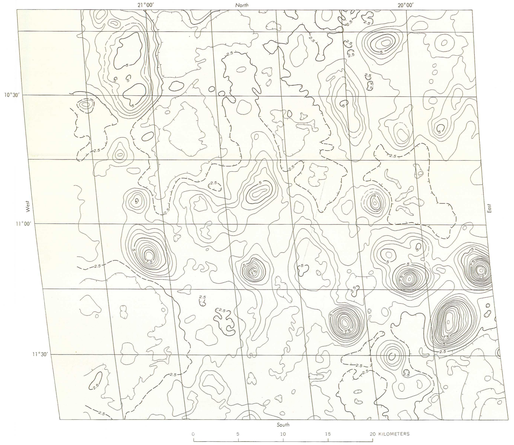
Crater rim
Number indicates type:
4-sharp-rimmed, deep crater having bright halo and interior slopes
3-sharp-rimmed, moderately deep crater having bright interior slopes
2-subdued crater, subdued rim, moderately shallow crater
1-subdued rimless shallow depression

GENERAL INFORMATION

This map is one of two geologic maps published by the U.S. Geological Survey that cover areas photographed by the Ranger VII spacecraft. The area is in the east-central part of Mare Cognitum 110 km (kilometers) south-west of the large subdued crater Bonpland. The bright-rayed craters Copernicus and Tycho lie 700 km to the north and 1,000 km to the south, respectively, and the area is close to the great circle passing between these two major craters. The relatively fresh crater Bullialdus is located 300 km to the south. The Ranger VII impact point is in the north-central part of the area.

In general, geologic maps of the Moon portray similarities and differences in the characteristics of the lunar surface. These characteristics, mainly topography and albedo, probably depend on the nature of the underlying rock units and the manner in which they formed. A review of the methods and results of lunar geologic mapping has been prepared by Wilhelms (1970). The origin of crater rays was discussed by Shoemaker (1962), who made a detailed analysis of the rays of Copernicus, some of which extend into this area. Information about the lunar surface for this map was obtained mostly from the Ranger VII photographs, which were taken with the setting sun approximately 25° above the horizon. Photographs from Lunar Orbiter IV taken under a rising sun, 19° above the local horizon, were used to fill in details around the margins of the map area where the Ranger data are poor.

Earlier discussions of the features portrayed on the map are contained in a report prepared by the principal investigators on the Ranger photographic experiment (Kuiper, 1965; Shoemaker, 1965; Urey, 1965; Whitaker, 1965). A larger scale map of a small area near the impact point has been prepared by Titley (1971).



ABSOLUTE NORMAL ALBEDO OF THE BONPLAND H REGION

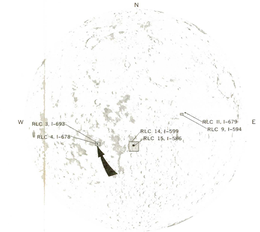
This small contour map shows the absolute normal albedo of the Bonpland H region and vicinity. Values shown by the contours correspond to albedo levels as follows:

Contour interval	Albedo interval
0 - 2.5	0.0842 - 0.0916
2.5 - 5.0	0.0916 - 0.0988
5.0 - 7.5	0988 - 1048
7.5 - 10.0	1048 - 1063
10.0	> 1063

The albedo contours were derived by first scanning the original negative of near full-Moon plate 5818 taken at the U.S. Naval Observatory, Flagstaff, Arizona (Oct. 9, 1965, phase angle 15.7°). The plate was scanned with a Joyce-Loebl microphotometer in combination with a Beckman and Whitley Isodensitracer (IDT). The tracings were converted to albedo levels by calibrating them with a map of absolute normal albedo (Poha and Wildey, 1970). The latter map was made from a combination of IDT tracings of Navy plate 8288D (June 3, 1966, phase angle 1.52°) and photoelectric scans of the brightness of the full Moon measured in absolute stellar magnitudes made at the time of exposure of plate 8288D.

The resolution of plate 5818 is superior to that of plate 8288D, and the contour intervals derived from it have a spacing one-fourth that of the contour intervals derived from the more nearly full-Moon plate 8288D. Thus, plate 5818 permits assignment of albedo values to many of the small features shown on this map. The general pattern of the contours derived from the tracing of plate 5818 for this map coincides closely with that of the contours derived from plate 8288D, indicating that the differences in phase angle between the two plates did not greatly affect the pattern of the isopleuses in this part of the Moon.

M.J. Grolier and James Woolridge assisted in obtaining the albedo data.



INDEX MAP OF THE EARTHSIDE HEMISPHERE OF THE MOON
SHOWING REGIONS MAPPED GEOLOGICALLY FROM RANGER PHOTOGRAPHS
Large letter indicates area of this report. Small number refers to base chart (RLC 3). Second number refers to published geologic map (I-693)

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For sale by U.S. Geological Survey, price $1.00