DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AND THE
USAF AERONAUTICAL CHART AND INFORMATION CENTER

GEOLOGY OF THE MOON
ARISTARCHUS REGION
I-465 (LAC-39)

NOTES ON BASE

The lunar base chart was prepared by USAF-ACIC with advisory assistance from Dr. G. P. Kuiper and his collaborators, D. W. G. Arthur and E. A. Whitaker

CONTROL

The position of features on this chart was determined through the use of selenographic control established primarily from the measures of J. Franz and S. A. Saunder as compiled by D. W. G. Arthur and E. A. Whitaker in the Orthographic Atlas of the Moon, edited by Dr. G. P. Kuiper, 1960.

VERTICAL DATUM

Vertical datum is based on an assumed spherical figure of the moon and a lunar radius of 1738 kilometers. The datum plane was subsequently adjusted to 2.6 kilometers below the surface described by the 1738 kilometer radius to minimize the extent of lunar surface of minus elevation value. Gradients of major surface undulations were established by interpolating Schrutka-Rechtenstamm computations of J. Franz's measurements of 150 moon craters. The accuracy of the datum as represented by contours is evaluated at 1000 meters. Vertical datum, as established is considered interim and will be refined as soon as a more accurate figure of the moon is determined

ELEVATIONS

All elevations are shown in meters. The relative heights of crater rims and other prominences above the maria and depths of craters were determined by the shadow measuring technique as refined by the Department of Astronomy, Manchester University, under the direction of Dr. Zdenek Kopal. Elevations of the lunar surface features have been referenced to the assumed vertical datum and have been integrated with the gradients of the surface undulations. The probable error of the localized relative height is 100 meters. Inherent with measuring techniques used, relative height determinations in the E-W direction are in general more accurate than in the N-S direction

Elevations (referenced to datum) ..... (100)
Depth of crater (rim to floor) ..... (400)
Relative elevations (referenced to surrounding terrain) 3004

Direction and extent of slope measured .....

CONTOURS

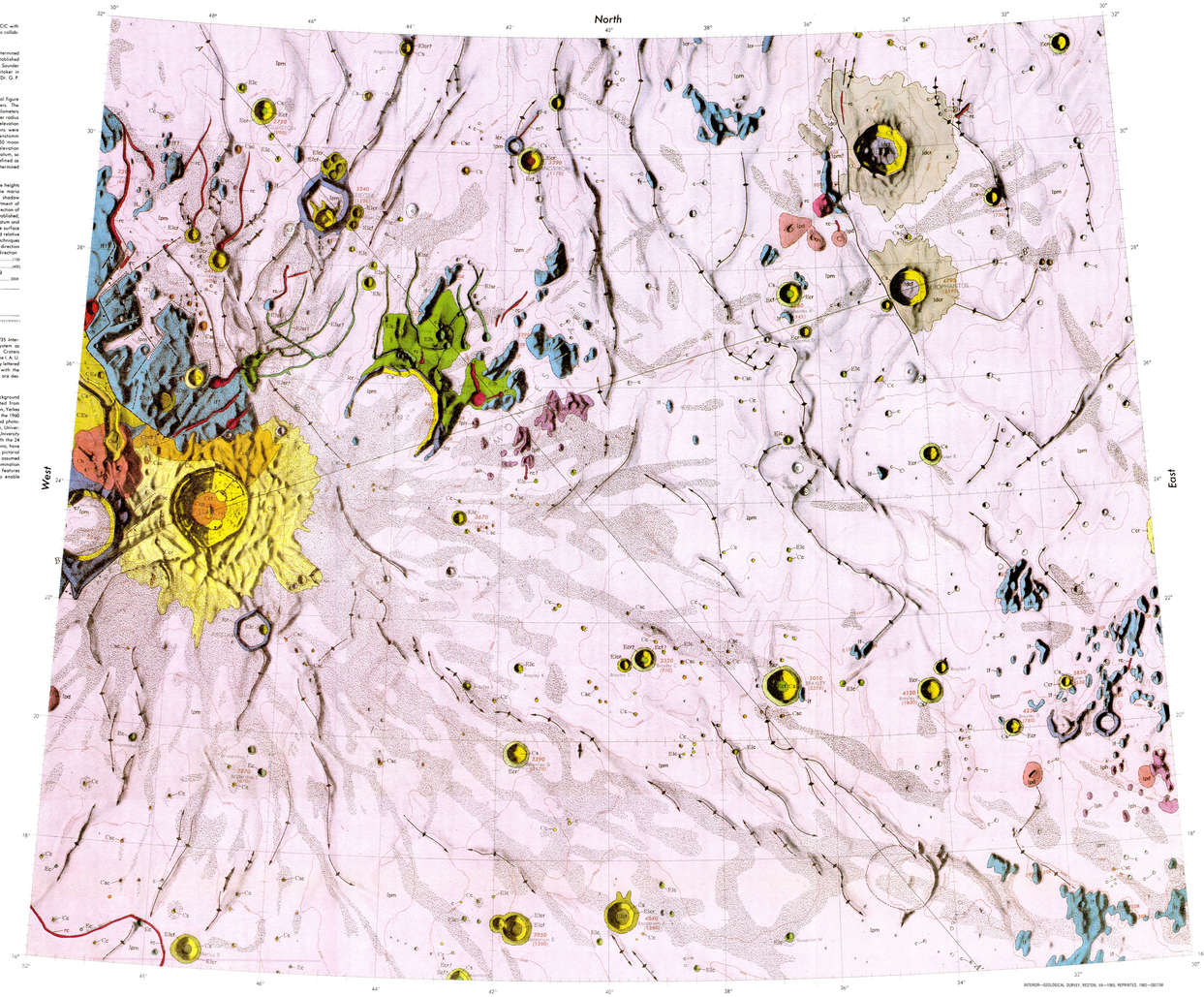
All contours are approximate.
Contour interval is 200 meters
Approximate contour 400
Depression contour .....

NAMES

The feature names were adopted from the 1935 International Astronomical Union nomenclature system as modified by Blagg and Muller, 1935. Craters were designated by capital letters were selected from the I. A. U. list of Named Lunar Formations. Supplementary lettered formations have been added in accordance with the criterion suggested by Blagg and Muller. They are designated by lower case letters

RELIEF PORTRAYAL

The configuration of the relief features and background coloration shown on this chart were integrated from photographs taken at Lick, McDonald, Mt. Wilson, Yerkes and Pic du Midi Observatories, and published in the 1960 Edition of the USAF Lunar Atlas, and unpublished photographs from the Lunar and Planetary Laboratory, University of Arizona, and Department of Astronomy, University of Manchester. Visual observations made with the 24 inch refractor at Lick Observatory, Mount Hamilton, also been used to add and clarify details. The pictorial portrayal of relief forms was 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 were eliminated to enable complete interpretation of relief forms

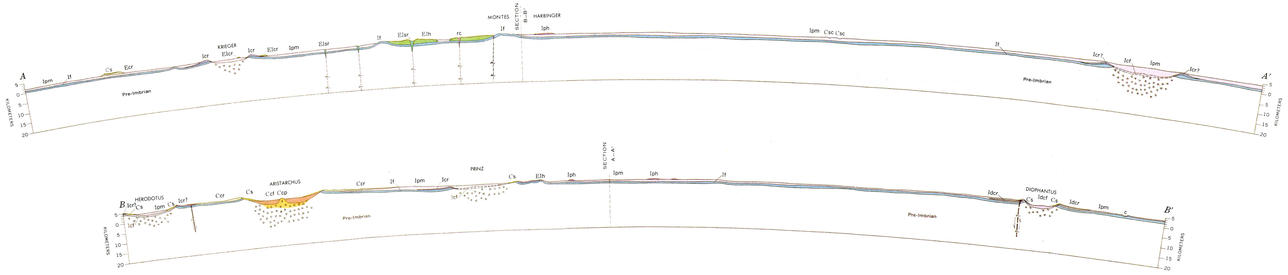


Lunar base chart LAC 39, 1st edition, 1963, by the Aeronautical Chart and Information Center, United States Air Force, St. Louis, Missouri 63118

SCALE 1:1 000 000
LAMBERT CONFORMAL PROJECTION
STANDARD PARALLELS 21°20' AND 42°40'

STATUTE MILES
KILOMETERS

Sources of geologic information: published photographs from Lick, Pic du Midi, and Mount Wilson Observatories; unpublished photographs from the Aeronautical Chart and Information Center, Lowell Observatory. Visual telescopic observations by H. J. Moore, made at Lick Observatory, 1963–65



Scale of cross sections is 1:1 000 000. No vertical exaggeration.
Sections lie approximately on great circles

GEOLOGIC MAP OF THE ARISTARCHUS REGION OF THE MOON

By
H. J. Moore
1965

EXPLANATION

Material exposed on the surface of the Moon is heterogeneous. The albedo and other physical characteristics that have been determined with the use of optical and radio telescopes vary from one part of the Moon to another, and the variations are partially correlated with differences in topography. Discontinuities in the areal variation permit the surface material to be divided into map units, each exhibiting a distinctive set of photometric properties associated with a limited range of topographic characteristics. Each map unit is further characterized by the textural patterns of distribution, and the patterns of certain units are in places superimposed on the patterns of other units. From the relations of superposition it is possible to determine the sequence in which the units were formed.

For the purpose of geologic mapping a classification has been adopted in which map units are grouped according to sequence or relative age. The major divisions of this classification are called systems (Shoemaker, 1962; Shoemaker and Hackman, 1962) and sub-divisions of the systems are called series.

PERIOD	EPOCH	EVENTS
Copernican		Formation of ray craters.
Eratosthenian		Formation of craters whose rims are no longer sharp.
Imbrian	Archimedian	Extensive deposition of lunar material of the Procellarum Group.
	Apenninian	Formation of craters older than at least part of the Procellarum Group
		Events related to the formation of the Mare Imbrium basin. Not yet formally divided.
pre-Imbrian time		

The boundaries or contacts and photometric and topographic characteristics of the map units have been determined by visual examination of photographs and telescopic observation. Albedo is described for full moon illumination. The photometric properties observed are those only of the material exposed at the surface. The distribution of certain units that are concealed or partly concealed by superimposed material has been inferred entirely from topographic characteristics.

Certain elements of the lunar topography suggest the presence of a variety of structural features in the lunar crust. These are indicated on the map with special symbols.

Each map unit and each type of probable structure have been given a descriptive name. An interpretive genetic name, where warranted, is given in parentheses beneath the descriptive name. A more detailed genetic interpretation follows the description of each unit and probable structure. These interpretations are based partly on analogy with terrestrial features and partly on analysis of the detailed interrelations of the features on the Moon, and are necessarily speculative. Discrimination and mapping of the units and determination of their sequence, however, are independent of the genetic interpretations placed on them.

The geologic mapping has been carried out to the precision obtainable with existing telescopic technique. As more detailed information is acquired through lunar exploration, further refinement of the chronologic sequence of map units will be possible and greater precision in the discrimination and location of geologic units and structures is to be expected.

A question mark after the crater label (Ecr?) implies that the stratigraphic designation is questionable.

REFERENCES CITED

Shoemaker, E. M., 1962, Interpretation of lunar craters, in Kopal, Zdenek, ed., Physics and Astronomy of the Moon: London, Academic Press, p. 283–359.
Shoemaker, E. M., and Hackman, R. J., 1962, Stratigraphic basis for a lunar time scale, in Kopal, Zdenek, and Mikhailov, Z. K., eds, The Moon—Symposium of the International Astronomical Union: London, Academic Press, p. 289–300.

COPERNICAN SYSTEM

Cs — Slope material (Talus)
Telescopic characteristics: *Albedo high to very high. Occurs mostly on slopes ranging from 25° to 45°*
Interpretation: *Talus and bedrock associated with slopes near angle of repose, freshly exposed by sliding and slumping*

Cr — Ray material
Telescopic characteristics: *Grades from moderately high albedo to albedo of surrounding material*
Interpretation: *Fine ejecta from primary and secondary impact craters*

Cc — Crater material, undifferentiated
Telescopic characteristics: *Albedo moderate to very high. Mapped only in craters too small for individual crater units to be differentiated*
Interpretation: *Craters undifferentiated as to genetic type*

Ccr / Ccrd — Crater rim material (Ejecta blanket)
Telescopic characteristics: *Albedo of Ccr moderate to very high, patchy. Areas of relatively low albedo around larger craters mapped as Ccrd. Topography around large craters is hummocky near rim crest. Low hummocks and low subradial ridges are present around flanks. Around small craters topography appears smooth. Crater rim material grades to ray material away from craters*
Interpretation: *Ejecta from large craters composed of crushed rock with large blocks*

Ccf — Crater floor material (Breccia)
Telescopic characteristics: *Albedo generally high to very high, patchy. Generally smooth or flat*
Interpretation: *Probably fragmental material. May be breccia lens, fall back, or slump material from walls*

Ccp — Central peak material
Telescopic characteristics: *Albedo generally high. Forms small hills on floors of craters*
Interpretation: *Probably fragmental material. May be brecciated bedrock exposed by decompression of rock or granitization rebound. May be mound of fragmental material formed by fall back or slumping from crater wall*

Csc — Copernican satellitic craters (Secondary impact craters)
Telescopic characteristics: *Small relatively shallow craters occurring in rays around large Copernican craters. Commonly compacted or elongate with very low rims or no observable rims. All craters closely associated with ray material are mapped as Csc. Some as large as 2 km. Some as deep-seated maybe older*
Interpretation: *Craters formed by impact of fragments ejected from large primary craters*

Ch — Cobra Head Formation* (Ejecta-flow blanket)
Telescopic characteristics: *Albedo moderate to very high, patchy. Smooth with low hummocks. Occurs on an elliptical area of positive relief approximately 35 kilometers across. Associated with sinuous rille (rima). Five small craters which are indicated by dashed lines. Type area of Vallis Schröteri (Cobra Head is informal topographic name)*
Interpretation: *Probably volcanic ash falls, ash flows, and lava flows*

Csr — Sinuous rille (rima) material
Telescopic characteristics: *Albedo generally low to moderate. Occurs within narrow sinuous depression*
Interpretation: *Probably includes at least a thin veneer of ash and dust or other volcanic rock; underlying material may be exposed in places. Fresh appearance and continuity with Ch mapped a Copernican age*

ERATOSTHENIAN SYSTEM

Ec — Crater material, undifferentiated
Telescopic characteristics: *Albedo low to moderate. Mapped only in craters too small for individual crater units to be differentiated*
Interpretation: *Craters undifferentiated as to genetic type*

Ecr / Ecrd — Crater rim material (Ejecta blanket)
Telescopic characteristics: *Albedo low to moderate. Topography around large craters is hummocky near the rim crest. Low hummocks and subradial ridges are present around flanks. Crater floor not filled with lpm*
Interpretation: *Ejecta from craters*

Ecf — Crater floor material (Breccia)
Telescopic characteristics: *Albedo low to moderate, relatively uniform. Topography generally smooth*
Interpretation: *Probably fragmental material. May be breccia lens, fall back, or slump material from walls, or possibly volcanic material*

IMBRIAN SYSTEM

Procellarum Group — Archimedian Series

lpm — Mare material
Telescopic characteristics: *Albedo generally low and uniform. Extensive, relatively smooth surfaces abruptly terminated against many topographic forms*
Interpretation: *Probably volcanic material; flows, ash falls, or both. Surface may be largely covered by fragmental materials. Ranges in thickness from zero to a few thousand meters*

lph — Hummocky mare material
Telescopic characteristics: *Albedo generally low and uniform. Forms isolated weakly hummocked surfaces surrounded by lpm*
Interpretation: *Probably volcanic flows. Surface may be largely covered by fragmental materials. Probably contemporaneous with lpm, but may be younger*

lpd — Dome material
Telescopic characteristics: *Albedo low and uniform. Forms domes up to 25 kilometers across and up to about 800 meters high*
Interpretation: *Probably chiefly volcanic flows; may include volcanic ash. Low slopes suggest dominantly basaltic composition*

lpr — Rough dome material
Telescopic characteristics: *Albedo low to moderate. Forms rough-topped domes up to 10 kilometers across. Local relief up to 600 meters above surrounding mare*
Interpretation: *Probably chiefly volcanic flows or breccia; may include pumice and volcanic ash. May be extrusion domes and flows, extrusion breccia, or volcanoes*

Procellarum Group — Apenninian Series

Idcr — Diophantus Formation*
Telescopic characteristics: *Albedo low to moderate, somewhat patchy. Topography of rim material (Idcr) like Ecr but partially buried by lpm. Floor material indicated by Idcf. Type area: crater Diophantus*
Interpretation: *Ejecta from craters Diophantus and Delisle (Idcr) like Ecr but partially buried by thin veneer of lpm. Floor (Idcf) probably fragmental material; possibly a breccia lens, fall back, or slump material from walls, or possibly volcanic material*

Idcf — Crater floor material
Telescopic characteristics: *Unit not exposed. Presence inferred by analogy with younger craters*
Interpretation: *Fragmental material. Probably a breccia lens, fall back or slump material from walls, or possibly volcanic material*

Ilc / Ilcr / Ilcf — Crater material, undifferentiated (Ilc); Crater rim material (Ejecta blanket) (Ilcr); Crater floor material (Breccia) (Ilcf)
Similar to corresponding Eratosthenian units but stratigraphic assignment uncertain

Ilh — Harbinger Formation*
Telescopic characteristics: *Albedo generally very low with gradual lateral variations. Circular or irregular areas up to a few tens of kilometers across. Includes craters associated with sinuous rilles (rima) on Montes Harbinger. Grades ingressively into mare material. Type area: west of mons. Harbinger*
Interpretation: *Probably volcanic ash falls, ash flows, and flows. Probably contemporaneous with or later than lpm*

Ilsr — Sinuous rille (rima) material
Telescopic characteristics: *Albedo low to high. Material lying within narrow sinuous depressions. Usually associated with craters at terminus of rille*
Interpretation: *Probably ash and dust or other volcanic rocks. Age not definitely established, but probably contemporaneous with, or later than lpm*

Ipr — Sr — Crater rim material (Ejecta blanket)
Telescopic characteristics: *Albedo low to moderate, patchy. Topography hummocky near crest of rim; low hummocks or low subradial ridges on flanks. Floor of crater and rim material partly covered with lpm*
Interpretation: *Ejecta from craters*

Ipf — Crater floor material
Telescopic characteristics: *Unit not exposed. Presence inferred by analogy with younger craters*
Interpretation: *Fragmental material. Probably a breccia lens, fall back or slump material from walls, or possibly volcanic material*

If — Fra Mauro Formation (Ejecta blanket)
Telescopic characteristics: *Albedo low to moderate. Exposed in areas of rough topography and on isolated hills surrounded by mare material (lpm). Rough surface may reflect underlying topography*
Interpretation: *Ejecta or other material around Mare Imbrium basin*

Chain crater material
Telescopic characteristics: *Material in and around aligned craters, low rim. Crater rim indicated by dashed line. Age unassigned*
Interpretation: *Volcanic craters*

Rille (rima) and chain-crater material
Telescopic characteristics: *Albedo low to high. Material lies within narrow linear depressions with associated small craters or within series of aligned craters*
Interpretation: *Probably includes breccia, fault blocks, and volcanic rocks. Age not definitely established but probably contemporaneous with, or later than lpm*

Crater
Undifferentiated as to age and type

Irregular depression

Rim of buried crater

Contact
Dashed where approximately located; queried where doubtful

Indefinite contact

Fault
Dashed where approximately located, dotted where partly or completely covered. Bar and ball on downthrown side

Lineament
Linear topographic feature. (Probable fault or fracture, partly or completely covered)

Mare ridge
Showing crest line. Tagged end indicated by arrowhead. Dashed where probable. (Probably underlain by anticline; possibly the site of a volcanic extrusion)

Rounded mare scarp
Showing trace of foot of scarp. Barbs point in direction of slope. Dashed where probable. (Probably a flow front or monocline)

Brecciated rock

*New name

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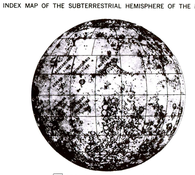

AREA OF ARISTARCHUS REGION

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