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

GEOLOGIC ATLAS OF THE MOON
CLEOMEDES QUADRANGLE
I-707 (LAC 44)

NOTES ON BASE

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

DATUM

The horizontal and vertical positions of features on this chart are based on selenocentric measurements made by ACIC and published in ACIC Technical Paper No. 15, "Coordinates of Lunar Features", March 1965. The assumed lunar figure is that of a sphere corresponding to the mean lunar radius of 1738 kilometers. Supplementary positions are developed in the chart area as an extension of the datum.

Primary Control Positions . . . . ⊕
Supplementary Control Positions . . . . △

ELEVATIONS

Radius vector lengths are the distances from the geometrical center of the moon to the plane of the crater rim or the designated position of the feature measured. The lengths of the radius vectors are expressed in kilometers.

The relative elevations of crater rims and other prominences above the surrounding terrain and depths of craters are in meters. They were determined by the shadow measuring techniques as refined by the Department of Astronomy, Manchester University, under the direction of professor Zdenek Kopal. The probable error of the localized relative elevations is 100 meters in the vicinity of the center of the moon with the magnitude increasing to 300 meters at 70° from the center due to foreshortening.

Lengths of Radius Vectors to control points . . . . . ⊕ or △ 1737.6
Depths of craters (rim to floor) . . . . (750)
Relative elevations (referenced to surrounding terrain) with direction and extent of measured slope indicated 910R

NAMES

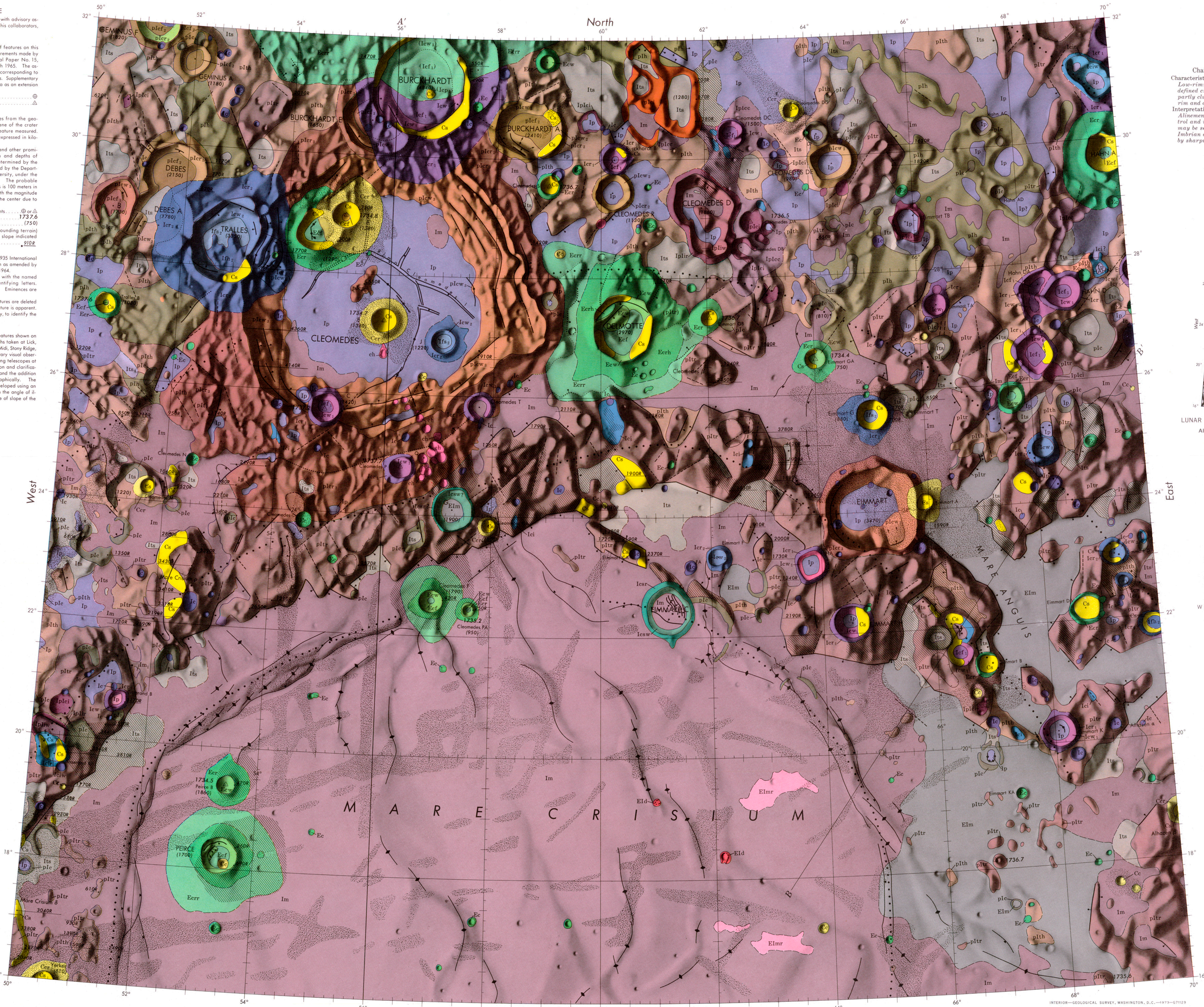
Feature names were adopted from the 1935 International Astronomical Union nomenclature system as amended by Commission 16 of the I.A.U., 1961 and 1964.

Supplementary features are associated with the named features through the addition of identifying letters. Craters are identified by capital letters. Eminences are identified by Greek letters.

Names of the supplementary lettered features are deleted when the association with the named feature is apparent. A black dot is included, where necessary, to identify the exact feature or features named.

PORTRAYAL

The configuration of the lunar surface features shown on this chart is interpreted from photographs taken at Lick, McDonald, Mount Wilson, Yerkes, Pic du Midi, Stony Ridge, and Kwasan Observatories. Supplementary visual observations with the 20 and 24-inch refracting telescopes at Lowell Observatory provide identification and clarification of indistinct photographic imagery and the addition of minute details not recorded photographically. 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.



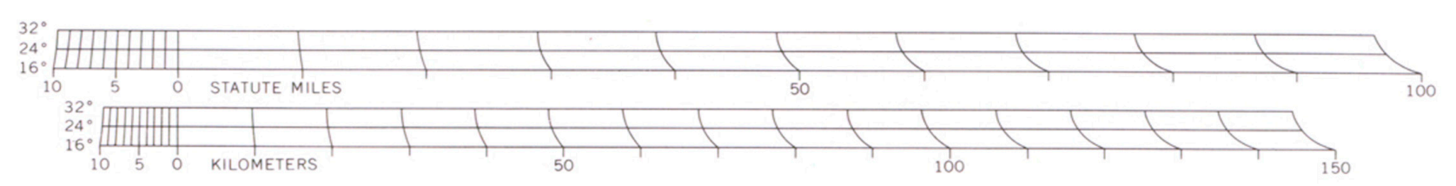
Lunar base chart LAC 44, 1st edition, 1965, by USAF Aeronautical Chart and Information Center, St. Louis, Missouri 63118

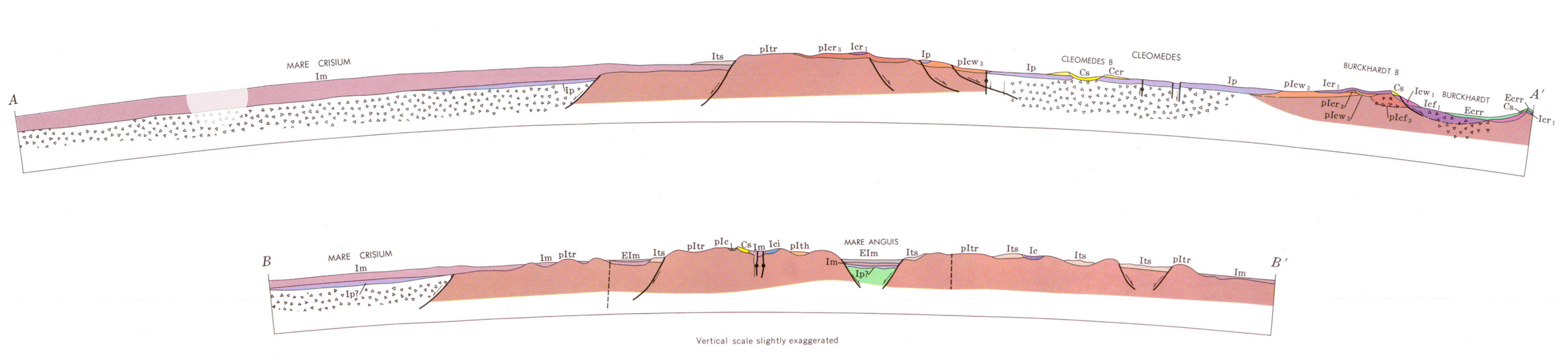
INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1973—G71129

Originally compiled by A. B. Binder 1964–1967 on the basis of telescopic photographs (Kuiper, 1960; Whitaker and others, 1964; Kuiper and others, 1967) and visual telescopic observations at the Steward Observatory 21-in reflector and the Lunar and Planetary Observatory 61-in reflector, University of Arizona. Map revised and explanatory material written 1969–1970 by C. J. Casella on the basis of Lunar Orbiter IV photographs (see index map). Albedo data from Pohn and Wildey (1970).

Prepared on behalf of the National Aeronautics and Space Administration contract No. R-66

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





Vertical scale slightly exaggerated

GEOLOGIC MAP OF THE CLEOMEDES QUADRANGLE OF THE MOON

By

Clarence J. Casella and Alan B. Binder

1972

UNITS NOT ASSIGNED AGES

Probably Imbrian or younger

ch

Chain crater material

Characteristics

Low-rimmed, moderately sharply defined craters, partly alined and partly clustered on south wall and rim and on floor of Cleomedes.

Interpretation

Alinement suggests structural control and internal origin, but some may be secondary impact craters. Imbrian or younger age suggested by sharpness

▨

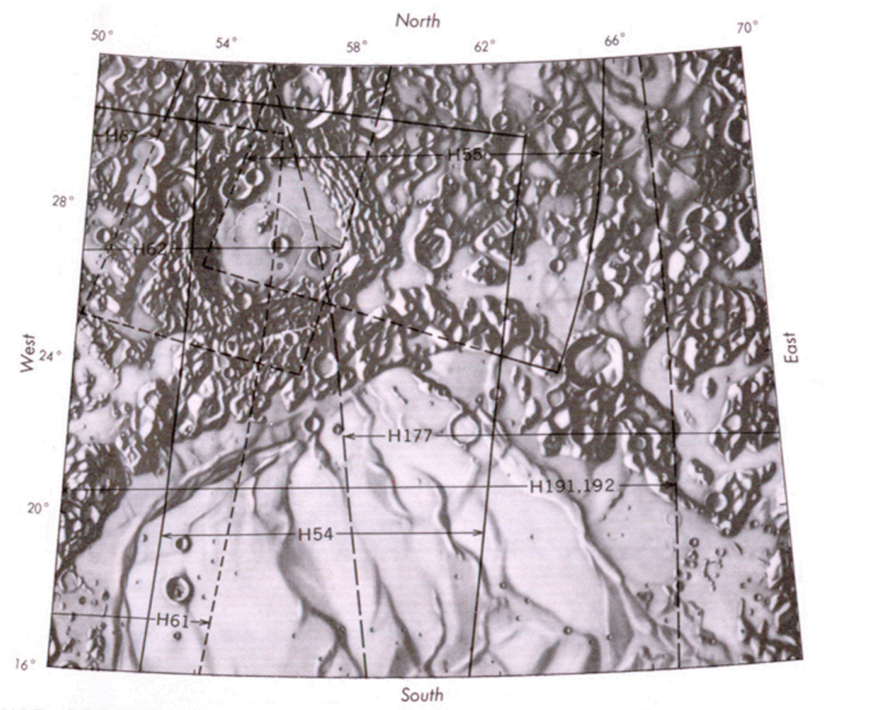
Dark mantling material

Characteristics

Albedo (.09–.11) lower than surrounding material. Just north of Tisserand K slightly subdues walls and floor of crater; otherwise has no visible relief. Associated mainly with irregular and smooth-rimmed craters but also on rims of Eratosthenian craters on mare and two small dark-haloed craters south of Delmotte

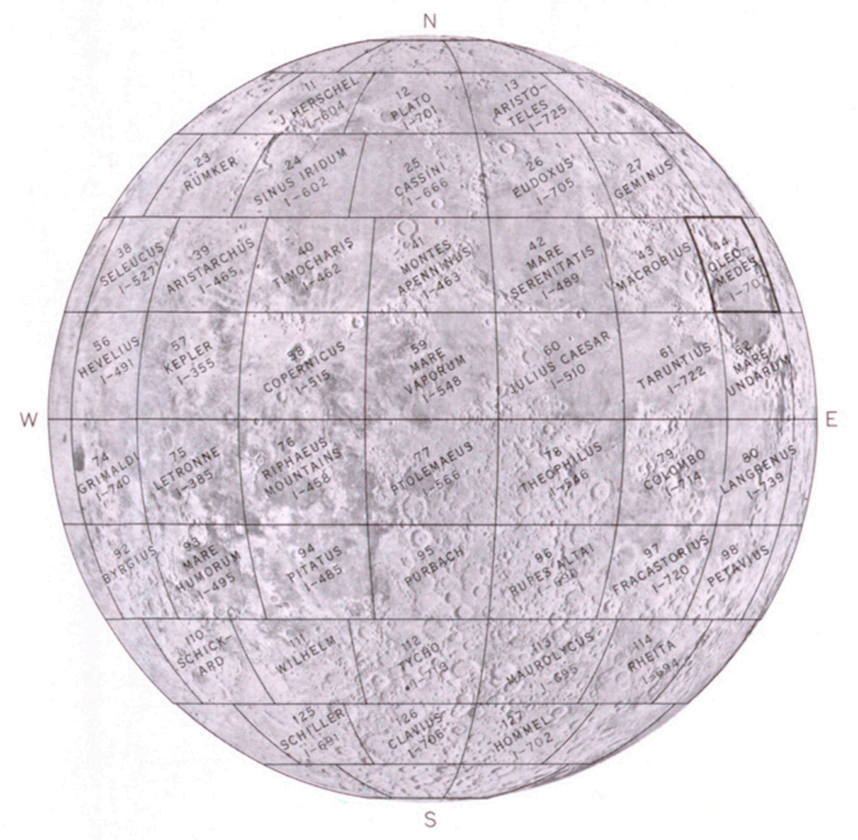
Interpretation

Material associated with irregular or smooth-rimmed craters, probably a thin blanket of tephra or ash-flow tuff. Material associated with Eratosthenian craters, of uncertain origin; may be either post-impact volcanic material or dark material excavated by impact



LUNAR ORBITER PHOTOGRAPHIC COVERAGE OF CLEOMEDES QUADRANGLE

All numbers refer to Lunar Orbiter IV high-resolution frames (150–400 m identification resolution). Earth-based telescopic photographs (foreshortened) and Apollo photographs taken after trans-Earth injection also cover quadrangle



INDEX MAP OF THE EARTHSIDE HEMISPHERE OF THE MOON

Number above quadrangle name refers to lunar base chart (LAC series); number below refers to published geologic map

E X P L A N A T I O N

COPERNICAN SYSTEM

Cs

Bright slope material

Characteristics

Albedo highest of any material in quadrangle (greater than 0.13). Occurs on steep crater walls and steep slopes in areas of high relief. Generally smooth at Orbiter IV scale

Interpretation

Fresh talus and freshly exposed bedrock resulting from mass movement and mechanical disintegration of rock

Cc | Ccr | Ccf

Materials of rayed craters

Characteristics

Craters having bright rays or halos, sharp, raised rim crests and high albedo. Eimmart A has high thermal anomaly during eclipse (Saari and Shorthill, 1966)

Cc, *crater materials, undivided. Craters too small for subunits to be mapped separately*

Ccr, *rim material. Material sloping outward from rim crest; hummocky, radially ridged, or smooth at Orbiter IV resolution. Around Eimmart A includes sharp hummocky dune-like material grading outward into bright ray system*

Ccf, *floor material. Flat surface in Cleomedes A that intersects base of crater wall along sharp topographic break*

Interpretation

Rim profile, dune pattern, and presence of rays or bright halos indicate explosive origin, most probably due to impact of meteorites. Inner part of rim material contains upturned and possibly faulted rock; broken and pulverized ejecta farther out. Floor material is fragmental ejecta, fallback, and material derived from wall. High thermal anomaly of Eimmart A probably due to relative freshness of material and more extensive bedrock exposure than in other craters

Ray material

Characteristics

Albedo generally high (greater than 0.10). Forms radial streaks and patches with no visible relief around Copernican craters. Easily visible against smooth, dark maria but less conspicuous on terra

Interpretation

Thin layer of ejecta and swarms of secondary and tertiary craters formed by materials ejected from primary and secondary craters

ERATOSTHENIAN SYSTEM

Ec | Ecr | Ecrh | Ecrr | Ecw | Ecf

Crater materials

Characteristics

Rayless craters whose morphology and albedo slightly more subdued than in Copernican craters

Ec, *crater materials, undivided*

Ecr, *rim material, undivided. Includes raised rim and irregular hummocky or braided material that grades into surrounding material. Mapped around intermediate-sized craters or where subunits poorly resolved. In larger craters divided into:*

Ecrh, *rim material, hummocky. Hummocky surface that descends outwards by series of arcuate terraces from rim crest down to surrounding topographic level, where grades into:*

Ecrr, *rim material, radial. Material of low topographic relief with finely braided texture radial to crater rim. Grades imperceptibly outwards into surrounding units which contain only poorly resolved satellitic craters*

Ecw, *wall material. In most small craters, smoothly concave upward; but commonly there is break in slope near rim crest between steep upper and gently sloping lower walls. In larger craters, wall consists of series of arcuate, flat-topped terraces. In some craters wall material forms arcuate lobes which partly mantle crater floor*

Ecf, *floor material. Forms flat or gently undulating surface in larger craters that intersects base of crater wall along sharp topographic break*

Interpretation

Similar in origin to corresponding Copernican units. Terraces in hummocky rim material probably outward thrust plates of rock, covered with coarse, poorly sorted ejecta. Radial rim material is thinner and finer ejecta

IMBRIAN OR ERATOSTHENIAN SYSTEM

EId

Material of cratered domes

Characteristics

Small, irregular domes with relatively large, irregular breached depression at summit (shown by dash-dot line). On Mare Crisium (two occurrences)

Interpretation

Cinder cones or similar features

EIm | Im

Mare materials

Characteristics

Dark, smooth, extensive plains with low broad elongated ridges and scarps. Embays topographically higher terrain, except for younger superposed craters

EIm, *mare material, dark. Lower crater density and lower albedo (0.08–0.09) than unit* Im

Im, *mare material. Albedo (0.09–0.10)*

Interpretation

Basalt and pyroclastic debris flows with some tephra. Lower crater density and albedo indicate EIm *is younger, but age uncertain*

EImr

Rough mare material

Characteristics

Clusters of closely-spaced, short, low ridges. Some sharp crested but others have smooth broad tops. A few have small irregular or elliptical summit craters like those of unit EId. *In southernmost patch, ridges run mainly northwest-southeast and northeast-southwest; less regularly oriented in other two patches. Albedo similar to surrounding mare*

Interpretation

Probably clusters of small intrusive or extrusive bodies localized along fractures in mare. Elliptical craters probably volcanic. May also include terra hills partly buried by thin mantle of mare material

IMBRIAN SYSTEM

Icr_2 | Icw_2 | Ifh_2 / Ifs_2

Crater materials

Characteristics

Craters whose rim materials and satellitic craters are superposed on Imbrian plains-forming materials but overlapped by mare materials; higher density of small superposed craters and more subdued rim crest than Eratosthenian craters. Albedo intermediate

Icr_2, *rim material. Includes raised rim and irregular hummocky material but lacks the radial material of units* Ecr *and* Ecrr

Icw_2, *wall material. In smaller craters wall smooth; in Tralles wall consists of series of arcuate scarps whose edges are less sharp than in unit* Ecw

Ifh_2, *floor material, hummocky. Hummocky material mostly on floor of Tralles. Size and shape of hummocks vary; a few have clefts at summits*

Ifs_2, *floor material, smooth. Smooth, flat material mostly on floor of Tralles*

Interpretation

Similarity to younger craters suggests impact origin. Hummocky floor mostly ejecta fallback; hummocks with clefts may be volcanic. Smooth floor material probably volcanic; overlies hummocks so is younger

Icsr | Icsw

Materials of smooth-rimmed craters

Characteristics

Icsr, *rim material. Includes sharp, fresh-appearing rim crest and narrow, smooth-surfaced rim flank. Lacks hummocky or braided ejecta patterns of similarly sharp rimmed craters. Queried where topography poorly observed and could be unit* Icr_2

Icsw, *wall material. Steeply sloping smooth surface lacking terraces. Eimmart C has series of scarps in mare on its floor that do not cut rim or wall but which occur along extension of two mare scarps outside crater. Queried where could be unit* Icw_2

Interpretation

Possible calderas because: rough ejecta lacking; Cleomedes G associated with dark mantling material; faults in Eimmart C apparently reflect same underlying structural control as mare ridges outside crater; fault pattern on floor of Eimmart C indicates central part of crater has collapsed

Ip

Plains-forming material

Characteristics

Plains with greater density of craters than on mare. Albedo intermediate. Occurs on floors of older craters, in extensive tracts, and in small intermontane areas

Interpretation

In larger tracts, material similar to mare material and volcanic in origin; more extensive cratering has resulted in brighter surface. Small intermontane areas possibly mass- [illegible]

Its

Smooth terra material

Characteristics

Surface of low relief that includes scattered, irregular or elliptical hillocks rising above flat or gently rolling surface. Occupies low areas in terra; overlaps rims and covers floors of older craters and occurs along base of steep scarp bordering Mare Crisium. Contacts with unit Ip *gradational; both units generally have same crater density and albedo except where unit* Its *mantled by dark material (line pattern)* [illegible]

Ic | Ici

Crater materials, undivided [illegible]

Icr_1 | Icw_1 | Icf_1 | Icp_1

Crater materials [illegible]

Ici | $Icir$ | $Iciw$

Materials of irregular craters [illegible]

Ipc

Clusters of irregular craters [illegible]

PRE-IMBRIAN

pIc | pIcr | pIcw | pIcf | pIcp

Crater materials [illegible]

pItr

Rugged terra material [illegible]

pIth

Hilly terra material [illegible]

pIh

Hummocky material [illegible]

Contact [illegible]

Fault [illegible]

Lineament [illegible]

Mare ridge [illegible]

Mare scarp [illegible]

Rim crest of buried crater

Irregular shallow depression [illegible]

Approximate crest line of basin ring structure

Slump block [illegible]

Brecciated rock [illegible]

INTRODUCTION AND STRATIGRAPHY

The Cleomedes quadrangle is broadly divisible into three provinces. First, the north half of Mare Crisium dominates the southern part of the area. Second, terra materials occur in concentric bands that alternate with mare or plains-forming materials in the northern part. These bands are interrupted by the crater Cleomedes whose associated materials dominate the northwest part of the map and form the third province.

The principles and methods of lunar geologic mapping have been described by Shoemaker (1962), Shoemaker and Hackman (1962), McCauley (1967) and Wilhelms (1970). The various map units are analogous to terrestrial rock-stratigraphic units and are defined by differences in topographic expression and albedo as seen on Lunar Orbiter, Apollo, and telescopic photographs. The relative age assignments are based on overlap and embayment relations, density of superposed craters, variations in albedo, and relative crater freshness. These units are then correlated with the stratigraphic section in and near the Imbrium basin and assigned to Moon-wide time-stratigraphic units. The Imbrian Period began with the formation of the Imbrium basin and extended to the time of formation of most of its mare surface materials. Units older than the basin are pre-Imbrian. Units coeval with the craters Copernicus and Eratosthenes belong to the Copernican or Eratosthenian Systems.

Most crater ages are based on the scheme of Pohn and Offield (1970) who assume that craters of similar size had similar initial forms and were modified progressively and predictably in time. Hence, the relative degree of freshness of crater wall, rim crest, and rim deposits is a measure of the relative age of the crater. By comparison with craters of known stratigraphic position, Offield (1971) assigns time-stratigraphic designations to craters not in contact with units of known age. This method is used here to assign ages to craters whose age is otherwise unclear.

The circular multi-ringed basins of the Moon have been placed in an age sequence by Hartmann (1964, p. 184), Wilhelms (1970, p. F13), and Offield and Pohn (1970) based on the freshness of surrounding structures and on the frequency and freshness of craters superposed on their edge. All agree that the Crisium basin was formed before the Imbrium basin. This is illustrated by the relations around Cleomedes. This crater interrupts structures concentric with Mare Crisium which are interpreted below as being created during the formation of the basin. It is therefore younger than the basin. Using the morphologic criteria of Pohn and Offield (1970) and Offield (1971) the age of Cleomedes is late pre-Imbrian. Hence, the time of formation of the Crisium basin is also pre-Imbrian.

The relative ages of the lunar maria have also been determined by Offield and Pohn (1970). They find the surface of Mare Crisium to be slightly older than the northern part of Mare Imbrium but roughly the same age as, or slightly younger than, its southern part. This southern Imbrium mare material is the informal type area of the top of the Imbrian System (Wilhelms, 1970, p. 23) so the mare material in the present map area is either Imbrian or slightly younger. However, this correlation is cast in doubt by the findings of Ronca and Green (1970, p. 345) who find that Mare Crisium has an anomalous density of craters of a certain morphologic type. As a result, because they assume a constant rate of crater formation, they have difficulty assigning it an age relative to the other maria.

Units here called "terra" are the most extensive in the uplands. Pre-Imbrian rugged terra (pItr) is a unit of large, generally irregular mountains which form rings concentric with the Crisium basin. The pre-Imbrian age is determined from overlap of the unit by ejecta from pre-Imbrian craters such as Cleomedes. Hilly terra (pIth) has lower relief; low areas appear partly filled in by either plains-forming or smooth terra materials of Imbrian age (Ip or Its) and the hills appear somewhat smoothed perhaps by erosion occurring later than the pre-Imbrian. Consequently, the surface materials of this unit may be partly Imbrian in age although the bulk of the materials are probably pre-Imbrian. Hummocky material (pIh) is similar but individual hills are more sharply defined and closely spaced. It bears resemblance to the Alpes Formation of the Imbrium basin (Page, 1970) and to hummocky terrain in the Orientale basin and may represent subdued ejecta of the Crisium basin; however its origin and age are difficult to determine because of the poor photographic coverage. Smooth terra (Its) has lower relief. It is assigned an Imbrian age because it has relatively few superposed craters, has gradational boundaries with plains materials which are probably Imbrian in age (Ip), and is overlain by ejecta from the upper Imbrian crater Tralles.

If the distribution of ejecta around younger impact basins, like Orientale and Imbrium, can be generalized and extended to all large lunar impact basins, the pre-existing terra around the Crisium basin must have been covered with ejecta as far as the fourth mountain ring and beyond—the entire Cleomedes quadrangle. Yet, hummocky material resembling the ejecta near younger impact basins is limited to small areas (unit pIh), and the outer, braided and lineated facies also typical of young impact basins, unless represented by lineated hilly terra material (pIth) west of Cleomedes, is absent or unrecognizable. Instead, the older terra units which, in general, form the uplands, and which were presumably covered by these ejecta, have a generally smooth surface. Apparently, erosion smoothed out at least the fine surface details of the ejecta even though the older terra units may preserve a veneer of this material.

The plains-forming material (Ip) and the mare units (Im and EIm) have flat but cratered surfaces and occur in extensive tracts or in restricted basins such as floors of older craters and the lowlands between Crisium basin mountains. The age of the plains-forming material is believed to be Imbrian because it covers the floors of many Imbrian-age craters (mostly lower Imbrian) but is overlain by ejecta from others (mostly upper Imbrian). It is assumed older than the mare because it has a higher density of small craters. The division between the two mare units is also based on crater density and on albedo. Unit EIm is more lightly cratered and darker and is thus probably the younger—possibly Eratosthenian. Cones with breached summit craters (unit EId) and more extensive tracts with similar features and sharp ridges (unit EImr) occur in Mare Crisium. These are certainly of volcanic origin and are probably contemporaneous with or somewhat younger than the flows or tuffs that are the mare material.

STRUCTURAL GEOLOGY

Mare Crisium is approximately 425 km north-south by 530 km east-west and occupies the center of a multi-ringed basin called the Crisium basin. Like other circular maria it is the site of a large positive gravity anomaly, or mascon (Muller and Sjogren, 1968, p. 683).

At the edge of Mare Crisium are many "islands" that are the tops of hills of basin materials partly buried by mare materials; the islands indicate the presence of a shallow shelf around the outer edge of the mare. The approximate mareward limit of these islands is marked by a system of mare ridges and low scarps that are approximately concentric with the border of the mare. These low scarps consistently face toward the interior of the mare, which therefore is slightly lower in average elevation than the shelf. These facts indicate that a buried scarp separates an inner, deeper part of the Crisium basin from the outer, higher shelf. The top of this scarp is the first or inner Crisium basin ring shown by large dots on the map. The scarp is generally curved but also has straight segments, especially along its eastern and western parts.

The mare is bordered by a steep basin scarp that rises, locally more than 3500 meters, to the mountainous crest of the second ring. This scarp is curved in places but it is also composed of straight segments. One generally straight segment south of Cleomedes is 250 km long. On a fine scale, this main scarp is serrated and is composed of many shorter straight scarps whose apparent topographic displacement indicates that most are fault scarps.

Along the north border of the mountain ring, marking the outer limit of this band of rugged terra material, is another prominent serrated scarp, this one facing north. It borders a narrow trough of mare material that includes Mare Anguis, and the scarp can be traced under the rim material of Cleomedes. Leading up to a third mountain ring and forming the north border of this trough is another south-facing scarp that has many deep, fault-bounded embayments. Thus, a concentric horst succeeded outward by a concentric graben ring Mare Crisium, except where interrupted by Cleomedes. Beyond the third ring, relief on the terra surface gradually diminishes northward to a low fourth ring that is also fronted by a concentric south-facing scarp. Only a short segment of this ring is exposed in the northeastern corner of the map.

Structures radial to Mare Crisium are poorly developed in the area. Three short, fault-bounded radial troughs border Mare Anguis northeast of the crater Eimmart, and other probable faults and lineaments occur west of Cleomedes. Radial ridges and troughs are more conspicuous west of Mare Crisium in the area of the Macrobius quadrangle (Hartmann, 1964, p. 180).

It has been shown convincingly by Baldwin (1963, p. 317), Van Dorn (1968, p. 1103), Mackin (1969, p. 736), Wilhelms and McCauley (1971) and many others, that mare-filled basins characterized by mascons and by concentric and radial scarps and troughs are the products of large impacts. The concentric rings probably result from the passage of shock waves (Van Dorn, 1968) that uplift the lunar rocks which then slump toward a central cavity. The Crisium basin is thus interpreted as an impact basin. The presence of straight segments in the concentric scarps around Mare Crisium and their serrated outline indicate either that the terrain was fractured before the impact and that explosive removal of material (Binder, 1967) or slumping took place along pre-existing planes of weakness, or, less probably, that fracturing after the impact, but before mare formation, reshaped the basin. Some linear segments, as long as 250 km, which tend toward a preferred orientation north-south, east-north-east, and north-west, are responsible for the elongate and rectilinear nature of the Crisium basin. These directions are parallel to the three major directions of what has been loosely termed the "lunar grid system" (Fielder, 1965, p. 114): a system of fractures and lineaments of problematical origin that occurs over the entire earth-side hemisphere of the Moon. The orientation of the fractures responsible for the shape of the Crisium basin is, therefore, most probably independent of the origin of the basin but reflects Moon-wide events.

Some "lunar grid" structures may have formed after the basin. Linear grooves parallel to faults of the basin scarps occur in various parts of the terra suface, but since basin ejecta probably covered all pre-basin lineaments, the present lineaments must represent rejuvenation of subsurface pre-basin fractures or new fracturing along the same general trends.

In addition to basin-concentric mare scarps and ridges, a set crosses the mare. Some of these scarps and ridges extend across the gap in the first ring between the craters Cleomedes F and Eimmart C and abut the scarp bordering the second ring. If the location of the concentric ridges and scarps is controlled by buried fractures in pre-mare terra materials then perhaps all mare ridges and scarps indicate the location of buried fractures. They would thus be indicative of the pattern of fracturing on the floor of the basin, which could be true even if mare ridges are the sites of fissure eruptions as concluded by Fielder (1965, p. 135).

The floor of the crater Cleomedes is fractured by a system of rilles. These are pairs of rectilinear, parallel scarps enclosing narrow graben valleys. The grabens are mostly concentric with the crater rim but some cross the crater floor and trend toward the crater wall. Their pattern is grossly similar to the patterns of fractures indicated by the ridges and scarps on Mare Crisium. Grabens indicate at least local tensional stresses perpendicular to their trends, and their concentric nature in Cleomedes indicates that the tensional stress field was mainly radial. The simplest, and most likely, explanation for this pattern is uplift of the floor of Cleomedes after the deposition of Imbrian plains material, but before the formation of the Eratosthenian crater Cleomedes E, whose rim material covers a graben. A possible mechanism for this uplift is isostatic rebound following impact excavation of the crater. The similarity in fracture patterns on the floors of Cleomedes and Mare Crisium may be explained by a similar uplift of the floor of the Crisium basin.

GEOLOGIC HISTORY

The earliest event recorded in the Cleomedes quadrangle is the impact that formed the Crisium basin. The shock-waves accompanying the impact produced a series of concentric and radial ridges and troughs, and excavated rock along pre-existing planes of weakness. Basin ejecta probably covered the quadrangle but is now unrecognizable with a few possible exceptions (unit pIh and certain lineated hilly terra material).

Cratering presumably has been a continuous process on the Moon. The apparent absence of pre-Crisium basin craters in the uplands suggests that they were covered by ejecta. However, some very subdued craters, mapped as pIc, may be their partly exhumed remnants. Post-basin cratering started in middle pre-Imbrian time, and its most important event was the formation of Cleomedes by impact in late pre-Imbrian time.

After the formation by impact of early Imbrian craters, large tracts of the lunar surface were covered with plains-forming material (Ip) as a result of regional volcanism. Some of the volcanic centers believed to have extruded these materials are mapped as irregular craters of Imbrian age (unit Ici). Perhaps some of this material also issued from fissures but their location is not obvious.

It is not known if volcanism was continuous until the close of the Imbrian Period or if there were distinct episodes. However, large outpourings of volcanic material occurred at the close of the Imbrian Period. The Crisium basin was partly filled, and the shelf between the first and second rings was buried under mare material. The marginal troughs and other low-lying areas to the north were also partly filled. The latest episode of regional volcanism apparently affected only the eastern part of the area. There, the lobate edge of dark mare material (EIm) may indicate the front of one or more lava or pyroclastic flows similar to those observed on Mare Imbrium (Fielder and Fielder, 1968).

After the Imbrian Period the major events were the formation, by impact, of craters of Eratosthenian and Copernican age. The crater Eimmart C and some of the dark-haloed irregular craters and small apparent cinder cones and other features in Mare Crisium may be the sites of local post-Imbrian volcanism.

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