DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AND THE
USAF AERONAUTICAL CHART AND INFORMATION CENTER

GEOLOGIC ATLAS OF THE MOON
LANGRENUS QUADRANGLE
I–739 (LAC–80)

GEOLOGIC MAP OF THE LANGRENUS QUADRANGLE OF THE MOON

By
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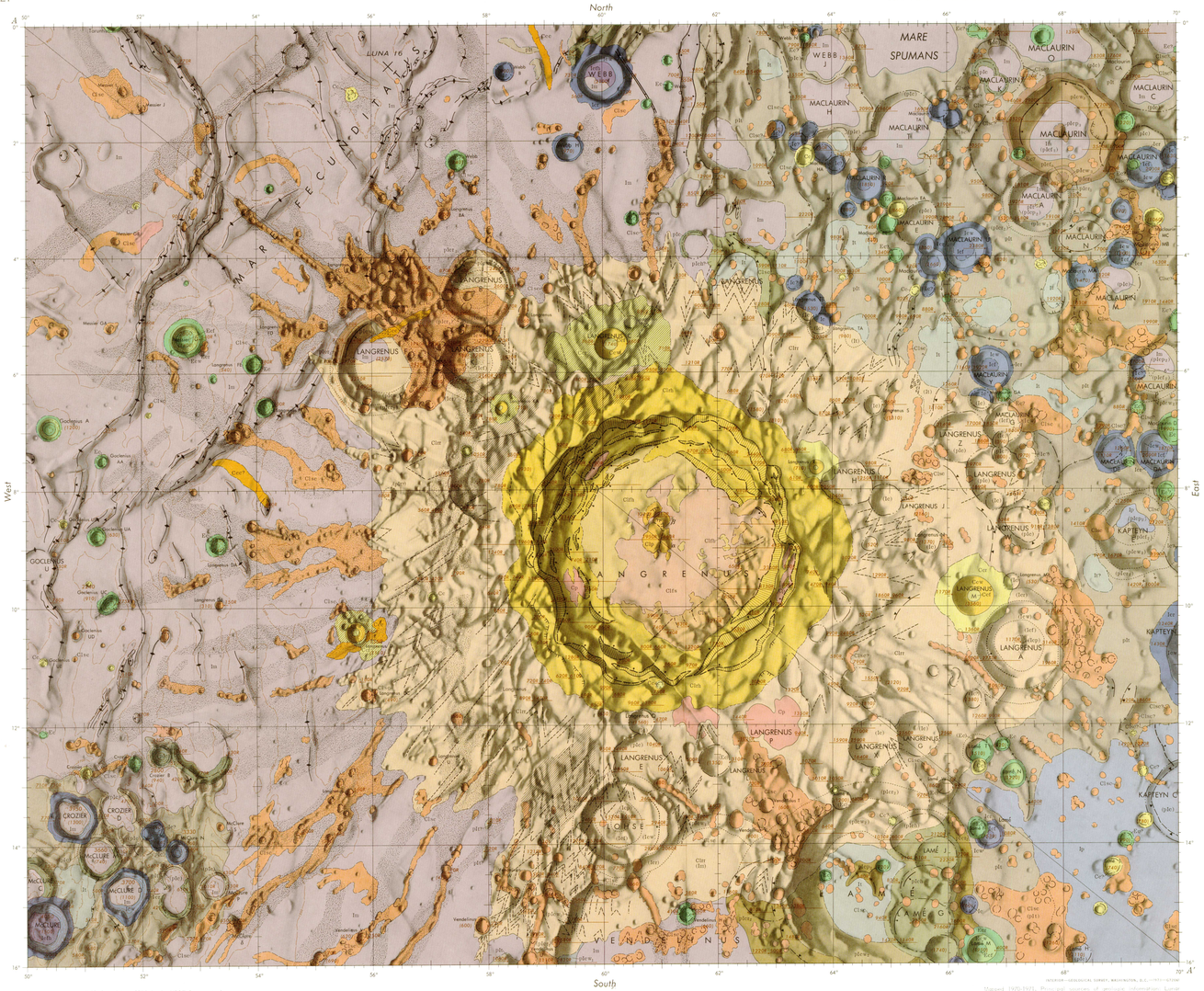
1973



Lunar base chart LAC 80, 1st edition, 1964, by the USAF Aeronautical Chart and Information Center, St. Louis, Missouri 63118

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.

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. Gerard P. Kuiper, 1960.

VERTICAL DATUM

Vertical datum is based on an assumed spherical figure of the moon and a mean radius of 1738.0 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 comparisons of J. Franz's measurements of 130 mean craters. The probable error of comparative elevation values 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 Professor Zdenek Kopal. Relative heights, thus established, 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 heights is 100 meters. Inherent with measuring technique is the fact that elevations are more accurate than the actual location are more accurate than the 14.5 direction.

Elevations (referenced to datum) 1100
Depth of crater (rim to floor) ..... (4000)
Relative Elevations referenced to surrounding terrain) with direction and extent of slope measured. 3000

CONTOURS

All contours are approximate
Contour interval is 500 meters
Approximate contour .....
Depression contour .....
NOTE: Contour information is not currently available beyond 56° East.

NAMES

The feature names were adopted from the 1935 International Astronomical Union Nomenclature system as amended by Commission 16 of the IAU.
Supplementary lettered features have been added in accordance with the system suggested by Blagg and Mueller. Craters are designated by capital letters. Ensimias are identified by Greek letters.

PORTRAYAL

The configuration of the relief features shown on this chart were interpreted from photographs taken at Luk, Ari, Donald, 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 Lowell refracting telescope, Flagstaff, Arizona, have 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.

EXPLANATION

Cc Ccr Ccw Cef
Crater materials

Characteristics
Rim crests subdued, commonly polygonal in plan; interior terraces, if present, generally scattered and discontinuous; exterior terraces rare; floors smooth and relatively level, may be hummocky; flanks of typical crater moderately steep to gentle; ejecta deposits relatively thin and discontinuous; secondary craters common in vicinity of large craters and basins, small compared to crater diameter; subdivisions analogous topographically to corresponding Copernican and Eratosthenian units but much more subdued
pIcc, rim material
pIcf, floor material
pIcf$_2$, floor material (buried unit)
pIcp, peak material
Interpretation
Craters of post-Cayleyan pre-Imbrian age; impact origin assumed, but distinctive characteristics largely obliterated by subsequent cratering and mantling; rim crests, floors, and ejecta deposits all subdued and flooded with mare basalt; direct evidence of relative age apparent; subdivisions assumed genetically analogous to corresponding Copernican and Eratosthenian crater units

Ccc
Crater cluster material

Characteristics
Circular, bowl-shaped craters; rim crests subdued; radial sculpture commonly evident; sharp contacts with large crater ejecta deposits; and flat floors; occur as irregular clusters of numerous craters, or possibly by dissipating gaseous cloud produced by impact

Cp
Plains material

Characteristics
Smooth, level surfaces with moderate to moderately high albedo, occurring on terrain within Langrenus and its depressions outside the quadrangle

Interpretation
Fine-grained pyroclastic or ejecta deposits; may be extensive mantle of material, as suggested by Gifford (1964), or may be relatively thin veneer of ejecta deposited last from gaseous cloud produced by impact

Clcr C
Material of Langrenus satellite craters

Characteristics
Associated with small shallow craters; rim crests subdued; material of subunit is always found to have reason; partial loops concave toward Langrenus; rim crests, subdued, smooth; floors, smooth; ridges, subdued, discontinuous; chains, and individuals occupied; prominent crater rim crests within clusters or chains indicated by hachured line

Interpretation
Secondary craters formed by impact of ejecta from Langrenus; may be subdivided by shallow depth, elongation, and/or alignment with respect to Langrenus, and by partial loops concave toward Langrenus

Clr Clrh Clw Clfh Clfs Clp
Materials of crater Langrenus

Characteristics
Rim crests distinguished by ray pattern, moderate thermal anomaly at eclipse, radar reflection anomaly, albedo as compared with surroundings; rim crests, subdued, smooth; flanks, moderately steep, subdued and dissected on basis of distinctive morphology and surface texture
Clr, rim material; smooth, irregular blocky ridges and hummocks; subdued and dissected on basis of distinctive morphology and surface texture
Clrh, rim material; hummocky. Irregular blocky collar of materials having high relief immediately exterior to rim crest; subdued and dissected on basis of distinctive morphology and surface texture
Clw, rim material; smooth, subdued and dissected on basis of distinctive morphology and surface texture
Clfh, rim material; hummocky. Irregular blocky collar of materials having high relief immediately exterior to rim crest; subdued and dissected on basis of distinctive morphology and surface texture; shows by banded pattern; characterized by albedo higher than that of rest of crater
Clfs, rim material; smooth. Irregular collar of materials of large relief but more subdued than that of Clfh; may be subdivided by dissected segments of crest of rim; subdued and dissected on basis of distinctive morphology and surface texture
Clp, rim material; hummocky. Irregular blocky collar of materials having high relief immediately exterior to rim crest; subdued and dissected on basis of distinctive morphology and surface texture
Interpretation
Secondary craters formed by ejecta from huge multi-ring Circular basin, Langrenus; may be subdivided by shallow depth, elongation, and/or alignment with respect to Langrenus suggested by alignment, shallow depth, irregular, radial to Langrenus, and/or partial loops concave toward Langrenus; may be subdivided by distinctive characteristics of rim crests; interior terraces and rectangularity; hummocky; but subdued rim and wall materials

Ec Ecr Ecw Ecf
Crater materials

Characteristics
Materials of steep-sloped craters, being moderate to moderately low albedo and moderate to low thermal anomalies at eclipse; subdivisions topographically similar to corresponding Copernican units, but generally somewhat more subdued; rays absent; craters 1–3 km in diameter not mapped unless isolated and therefore "landmarks"
Ec, rim material
Ecr, rim material
Ecw, wall material
Ecf, floor material
Interpretation
Secondary origin of craters suggested by similarities to Copernican craters having characteristics more satisfactorily explained by impact origin; rays believed to have been present originally but to have faded with time; reduced thermal anomaly at eclipse attributed to gradual insulation of rock fragments from solar heat by dust; floor deposits probably relatively thin; subdivisions analogous to corresponding Copernican units, but generally somewhat more subdued; craters 1–3 km in diameter not mapped unless isolated and therefore "landmarks"

Im
Mare material

Characteristics
Level plains material of basal lateral extent, having low to moderately low albedo; topographically lower than adjacent terrae, with much lower density of superposed craters, excluding Langrenus secondary craters; prominent curvilinear ridges and scarps within mare indicated by structural symbols

Interpretation
Volcanic materials, mainly flows of basaltic composition, possibly interspersed with pyroclastic deposits; flooding of Langrenus and other craters and basins by mare basalt; ages relative to adjacent units suggested by presence or absence of superposed craters (Baldwin, 1949; Kuiper, 1961; Hartmann and Kuiper, 1962)

Ic Icr Icw Icf Icfh Icp
Crater materials

Characteristics
Materials of craters with prominent rim crests and smooth or slightly hummocky but subdued flanks; moderately high density of craters superposed on rim materials; subdivisions analogous topographically to corresponding Copernican and Eratosthenian age but more subdued; rays absent; craters 1–3 km in diameter not mapped unless isolated and therefore "landmarks"
Ic, crater materials, undivided. Small craters, generally <10 km; topographically sharp, consist of bowl-shaped interiors, subdivided morphologically as Icpr craters and Icfcraters
Icr, rim material. Generally hummocky around rim crest; may be subdivided by shallow depth, elongation, and/or alignment with respect to Langrenus suggested by alignment of ejecta; by distinctive characteristics of rim crests; interior terraces and rectangularity; hummocky; but subdued rim and wall materials
Icw, wall material. Steep bright slopes of crater interiors; generally smooth
Icf, floor material. Flat or cratered surface in central crater
Interpretation
Impact origin of crater materials suggested by hummocky rim structure, circular symmetry, and presence of rays. High thermal anomaly at eclipse (Saari and Shorthill, 1963; Saari, Shorthill, and Adams, 1964); much of the material deposited ballistically, but relief probably due in large part to faulting and settling of bedrock blocks and crater floors as well as to deposition of ejecta; rays of low albedo possibly reworked mare material with high Fe and Ti; albedo of rays probably due to fine-grained ejecta (Gifford, 1964); local bedrock outcrops; floor materials probably colluvium, breccia resulting from impact, and fallback

Ir Irh
Terra materials

Characteristics
Small patches of smooth, gently undulating material located mainly on inferior elevations of terra; density of superposed craters less than on adjacent terrain, excepting Langrenus secondary craters; very indistinct contact with pre-Imbrian
Possibly erosional, resulting from cutting of deeply buried craters by younger mare material; may be partly volcanic, as suggested by Gifford (1964)
Irh, hummocky

Interpretation
Fine-grained ejecta deposited on adjacent terrain; may be partly volcanic, as suggested by Gifford (1964)

Ipl
Ray material

Characteristics
Albedo relative to adjacent terrain; generally occurring in radial streaks or halos around Copernican craters; highest albedo around impact craters; albedo reduced with distance from crater with satellitic craters having albedo similar to that of crater; albedo reduced to that of adjacent terrain at distance of 1 crater diameter; rays commonly have sharp contacts with adjacent terrain, but diffuse contacts with small rays; rays commonly radial to Tycho, Copernicus, Kepler, Aristarchus, and Langrenus craters; rays commonly absent from craters of Eratosthenian age

Interpretation
Ejecta deposited ballistically as low trajectory cloud of poorly sorted debris, migrating as a mass downrange; "herringbone" texture likely formed by edges of moving, disrupted and streamlined pseudocontemporaneously by cloud of gasses and debris
Clr, structural control evidenced by subdued lineations in terrain slopes and fault blocks, localized in part by fine rimfa; gradational contrast with mid Clfs and downward with Clfh; subdivisions analogous topographically to corresponding Copernican units
Clw, bedrock blocks accompanied by fine-grained material, suggesting localized contour fracturing
Clfh, hummocky probably composed of bedrock blocks disrupted by impact
Clfs, rims probably structural in origin to smooth floors; Clfs on instate surfaces, and in depressions outside rim crest; original polygonality of sectors state suggested by smooth, flat floor materials; subdivisions possibly existent from steep-seated fractures; part of fine material probably contributed by mass wasting of debris from slopes adjacent to topographic lows; possibly in part volcanic, as suggested by Gifford (1964); and/or impact melt
Clp, broad undulating surface of rock debris, derived from adjacent high ground, formed in response to deformation caused by impact (Dence, 1968); upward movement of materials from depth through zone of intense crushing of blocks along walls (Wilshire, Offield, Howard, and Cummings, 1971); equivalent in part to hummocky rim materials and probably gradational at depth with undisturbed bedrock

Clcr
Material of Langrenus satellite craters

Characteristics
Associated with small shallow craters; rim crests subdued; material of subunit is always found to have reason; partial loops concave toward Langrenus; rim crests, subdued, smooth; floors, smooth; ridges, subdued, discontinuous; chains, and individuals occupied; prominent crater rim crests within clusters or chains indicated by hachured line

Interpretation
Secondary craters formed by impact of ejecta from Langrenus; may be subdivided by shallow depth, elongation, and/or alignment with respect to Langrenus, and by partial loops concave toward Langrenus

Clr Clrh Clw Clfh Clfs Clp
Materials of crater Langrenus

Characteristics
Rim crests distinguished by ray pattern, moderate thermal anomaly at eclipse, radar reflection anomaly, albedo as compared with surroundings; rim crests, subdued, smooth; flanks, moderately steep, subdued and dissected on basis of distinctive morphology and surface texture
Clr, rim material; smooth, irregular blocky ridges and hummocks; subdued and dissected on basis of distinctive morphology and surface texture
Clrh, rim material; hummocky. Irregular blocky collar of materials having high relief immediately exterior to rim crest; subdued and dissected on basis of distinctive morphology and surface texture
Clw, rim material; smooth, subdued and dissected on basis of distinctive morphology and surface texture
Clfh, rim material; hummocky. Irregular blocky collar of materials having high relief immediately exterior to rim crest; subdued and dissected on basis of distinctive morphology and surface texture; shows by banded pattern; characterized by albedo higher than that of rest of crater
Clfs, rim material; smooth. Irregular collar of materials of large relief but more subdued than that of Clfh; may be subdivided by dissected segments of crest of rim; subdued and dissected on basis of distinctive morphology and surface texture
Clp, rim material; hummocky. Irregular blocky collar of materials having high relief immediately exterior to rim crest; subdued and dissected on basis of distinctive morphology and surface texture
Interpretation
Secondary craters formed by ejecta from huge multi-ring Circular basin, Langrenus; may be subdivided by shallow depth, elongation, and/or alignment with respect to Langrenus suggested by alignment, shallow depth, irregular, radial to Langrenus, and/or partial loops concave toward Langrenus; may be subdivided by distinctive characteristics of rim crests; interior terraces and rectangularity; hummocky; but subdued rim and wall materials

Ec Ecr Ecw Ecf
Crater materials

Characteristics
Materials of steep-sloped craters, being moderate to moderately low albedo and moderate to low thermal anomalies at eclipse; subdivisions topographically similar to corresponding Copernican units, but generally somewhat more subdued; rays absent; craters 1–3 km in diameter not mapped unless isolated and therefore "landmarks"
Ec, rim material
Ecr, rim material
Ecw, wall material
Ecf, floor material
Interpretation
Secondary origin of craters suggested by similarities to Copernican craters having characteristics more satisfactorily explained by impact origin; rays believed to have been present originally but to have faded with time; reduced thermal anomaly at eclipse attributed to gradual insulation of rock fragments from solar heat by dust; floor deposits probably relatively thin; subdivisions analogous to corresponding Copernican units, but generally somewhat more subdued; craters 1–3 km in diameter not mapped unless isolated and therefore "landmarks"

Im
Mare material

Characteristics
Level plains material of basal lateral extent, having low to moderately low albedo; topographically lower than adjacent terrae, with much lower density of superposed craters, excluding Langrenus secondary craters; prominent curvilinear ridges and scarps within mare indicated by structural symbols

Interpretation
Volcanic materials, mainly flows of basaltic composition, possibly interspersed with pyroclastic deposits; flooding of Langrenus and other craters and basins by mare basalt; ages relative to adjacent units suggested by presence or absence of superposed craters (Baldwin, 1949; Kuiper, 1961; Hartmann and Kuiper, 1962)

Ic Icr Icw Icf Icfh Icp
Crater materials

Characteristics
Materials of craters with prominent rim crests and smooth or slightly hummocky but subdued flanks; moderately high density of craters superposed on rim materials; subdivisions analogous topographically to corresponding Copernican and Eratosthenian age but more subdued; rays absent; craters 1–3 km in diameter not mapped unless isolated and therefore "landmarks"
Ic, crater materials, undivided. Small craters, generally <10 km; topographically sharp, consist of bowl-shaped interiors, subdivided morphologically as Icpr craters and Icfcraters
Icr, rim material. Generally hummocky around rim crest; may be subdivided by shallow depth, elongation, and/or alignment with respect to Langrenus suggested by alignment of ejecta; by distinctive characteristics of rim crests; interior terraces and rectangularity; hummocky; but subdued rim and wall materials
Icw, wall material. Steep bright slopes of crater interiors; generally smooth
Icf, floor material. Flat or cratered surface in central crater
Interpretation
Impact origin of crater materials suggested by hummocky rim structure, circular symmetry, and presence of rays. High thermal anomaly at eclipse (Saari and Shorthill, 1963; Saari, Shorthill, and Adams, 1964); much of the material deposited ballistically, but relief probably due in large part to faulting and settling of bedrock blocks and crater floors as well as to deposition of ejecta; rays of low albedo possibly reworked mare material with high Fe and Ti; albedo of rays probably due to fine-grained ejecta (Gifford, 1964); local bedrock outcrops; floor materials probably colluvium, breccia resulting from impact, and fallback

Ir Irh
Terra materials

Characteristics
Small patches of smooth, gently undulating material located mainly on inferior elevations of terra; density of superposed craters less than on adjacent terrain, excepting Langrenus secondary craters; very indistinct contact with pre-Imbrian
Possibly erosional, resulting from cutting of deeply buried craters by younger mare material; may be partly volcanic, as suggested by Gifford (1964)
Irh, hummocky

Interpretation
Fine-grained ejecta deposited on adjacent terrain; may be partly volcanic, as suggested by Gifford (1964)

Ipl
Ray material

Characteristics
Albedo relative to adjacent terrain; generally occurring in radial streaks or halos around Copernican craters; highest albedo around impact craters; albedo reduced with distance from crater with satellitic craters having albedo similar to that of crater; albedo reduced to that of adjacent terrain at distance of 1 crater diameter; rays commonly have sharp contacts with adjacent terrain, but diffuse contacts with small rays; rays commonly radial to Tycho, Copernicus, Kepler, Aristarchus, and Langrenus craters; rays commonly absent from craters of Eratosthenian age but more subdued; rays absent; craters 1–3 km in diameter not mapped unless isolated and therefore "landmarks"

Interpretation
Ejecta deposited ballistically as low trajectory cloud of poorly sorted debris, migrating as a mass downrange; "herringbone" texture likely formed by edges of moving, disrupted and streamlined pseudocontemporaneously by cloud of gasses and debris

Ipl
Plains material

Characteristics
Smooth, level terrain, bounded by large, circular escarpments east and west of map area; moderately high albedo; numerous superposed craters, excepting Langrenus secondary craters; very indistinct contact with pre-Imbrian

Interpretation
Possible formation as flood or nonflood volcanic material suggested by Gifford (1964); may be partly equivalent to Cayley Formation, as suggested by Wilhelms and Wilhelms, 1967

Ipl$_1$ plw$_1$ plf$_1$ plfs$_1$
Crater materials

Characteristics
Rim crests subdued, commonly polygonal in plan; interior terraces, if present, generally scattered and discontinuous; exterior terraces rare; floors smooth and relatively level, may be hummocky; flanks of typical crater moderately steep to gentle; ejecta deposits relatively thin and discontinuous; subdivisions analogous topographically to corresponding Copernican and Eratosthenian units but much more subdued
plw$_1$, rim material
plf$_1$, floor material
plf$_1$, floor material
plfs$_1$, peak material
Interpretation
Craters of post-Cayleyan pre-Imbrian age; impact origin assumed, but distinctive characteristics largely obliterated by subsequent cratering and mantling; rim crests, floors, and ejecta deposits all subdued and flooded with mare basalt; direct evidence of relative age apparent; subdivisions assumed genetically analogous to corresponding Copernican and Eratosthenian crater units

plt
Terra material

Characteristics
Rim crests subdued, commonly interrupted by numerous superposed flatfloored craters; rim crests, subdued, apparently scattered; crater chains, variable, but generally high relief; topographically sharp to subdued; apparently buried craters

Interpretation
Material of variable thickness forming mantle over older terrain and subduing early pre-Imbrian craters; possibly volcanic, as suggested by Gifford (1964); may be partly equivalent to basin units of map area; Imbrian Cayley Formation, as composed of older crater remnants, Procellarian basin material, and, speculatively, original differentiate of lunar crustal material

plch
Crater chain material

Characteristics
Rim crests shallow, overlapping craters southeast of Langrenus crater; extending into adjacent Petavius quadrangle; crescent diameters approximately 20 km to 30 km, with progressive decrease in diameter and development to overlap relative to north; parallel to elongation of ridge with scalloped base north of Langrenus

Interpretation
Secondary craters formed by ejecta from huge multi-ring Circular basin, Langrenus; may be subdivided by shallow depth, elongation, and/or alignment with respect to Langrenus suggested by alignment, shallow depth, irregular, radial to Langrenus, and/or partial loops concave toward Langrenus; may be subdivided by distinctive characteristics of rim crests; interior terraces and rectangularity; hummocky; but subdued rim and wall materials

plfs$_2$ plw$_2$ plf$_2$ plfs$_2$
Crater materials

Characteristics
Rim crests subdued and scattered, slumped, hummocky walls, lacking terraces; subdued central peak; rim materials indistinct; subdivisions analogous topographically to corresponding units of younger craters but considerably more subdued; craters apparently buried, except Lade
plw$_2$, rim material
plw$_2$, wall material
plf$_2$, floor material (buried unit)
plfs$_2$, peak material
Interpretation
Craters of pre-Imbrian but subdivisions believed genetically similar to corresponding units of younger impact craters; no evidence of volcanic origin, but interpretive criteria obliterated by degradation. pre-Cayleyan age inferred from apparent burial by unit plt, and superposition of unit plch on Lade; post-early pre-Imbrian age implied by superposition of Lade on Vendelinus

plcr$_1$ plw$_1$
Crater materials

Characteristics
Rim crests subdued, mainly by exposed portion of wall of crater Vendelinus, and pressured buried rim fragments; rim crests rounded and largely doubled by younger units or interrupted by numerous superposed craters; interior terraces and rectangularity; hummocky; but subdued rim and wall materials
plcr$_1$, rim material (buried unit)
plw$_1$, wall material
Interpretation
Craters formed during early stages of lunar history; generally large, and believed of impact origin, but lacking diagnostic criteria; rim materials and most of wall of Vendelinus buried by younger crater materials; floor buried by mare materials

(Ec)
Concealed crater rim
Crater rim crests recognized topographically but marked by younger material; rays absent; in parentheses where extrapolation reasonably certain, but geologic units not subdivided

Buried crest
Lunar or buried unit indicated in parentheses, inferred on basis of topographic expression

Rim crest within geologic unit
Use generally confined to small craters 10 km or less where materials not subdivided

Laterally gradational contact
Shown only in cross-section; corresponding to short-dashed contact on map

Crest
Line along base or crest, whichever most obvious, of prominent scarp; generally coincident with contact or some where short-dashed where approximate; coincident with contact or some where

Fault
Line at base of sharp scarp; dashed where inferred; dotted where concealed; U, upthrown side; D, downthrown side; generally coincident with contact at some places; sawtoothed indicated by ball between closely spaced lines

Scarp
Interpretation: Sublimed or faulted fault scarp or partial crater rim; dotted possibly lavenbles or buried terra materials

Terra ridge
Line along crest of prominent ridge in highlands
Interpretation: Tectonic feature, or possibly old crater rim segments so degraded as to be unrecognizable

Lineament
Narrow shallow groove, associated in some cases with low ridge, V-shaped "herringbone" pattern especially prominent in mare areas; may be fault, fissure, or shear; generally northwest and southeast of crater possibly a result of oblique lighting on photographs; pattern probably arranged symmetrically around crater
Interpretation: Structural element / fault or graben; mantling of fine-grained material, as suggested by Gifford, to flow mechanism of debris "cloud" from Langrenus

Scarp within crater
Prominent scarp with shorter lower slopes of adjacent materials exposed on interior wall of crater; sawtooth / fault or basin
Interpretation: Rim materials exposed and truncated by crater; terrace scarps probably caused by successive faulting of rim

Mare ridge
Line along approximate axis of ridge; commonly discontinuous or "beaded" in plan and irregular in cross-section; several ring or partial ring structures at ridge intersections
Interpretation: Mare crest wrinkled along ridge, possibly by expansion/cooling of molten lava from relatively shallow depth

Dark material
Patches of Langrenus rim materials having moderately low albedo, contrasting with most of rim having higher albedo; also, mantling material of low albedo
Interpretation: Ejecta of low albedo, possibly reworked mare material with high Fe and Ti content

Highlands trough
Line along axis of broad depression in terra materials; no genetic connotation implied

Breccia lens
Shown only in cross-section beneath crater floors
Interpretation: Breccia produced by crater/ensuing impact

NOTE: Albedo data are based on map by Pohn, Wilcox, and Sutton (1970); qualitative terms used herein have been applied arbitrarily to the numerical scale as follows: very low .069–.079; low .079–.096; moderately low .096–.106; moderate .106–.116; moderately high .142–.159; high .159–.192; very high .192–.238.

GEOLOGIC SETTING

The Langrenus quadrangle is on the east limb of the lunar nearside, at the southeast margin of Mare Fecunditatis. The crater Langrenus, about 140 km in diameter, is the most prominent feature. Rugged terra materials, scarred by craters of various sizes and ages, occupy much of the east half of the map area, and smooth mare materials in the Fecunditatis basin dominate the west. Mare Spumans and other small irregular maria in the northeast are part of a belt of such maria concentric with Mare Crisium, which is centered approximately 500 km north of the quadrangle.

STRATIGRAPHY

All four major categories of lunar geologic units—materials of terrae, plains, craters, and maria—occur in this quadrangle. These materials are placed in chronologic sequence according to stratigraphic position and (or) photogeologic characteristics (Shoemaker and Hackman, 1962; McCauley, 1967; Wilhelms, 1970). Geologic interpretations are also influenced by the results of these objectively defined units. Gifford (1964) and Eggleton and Schmitt (1967) suggested that mare materials darken with time owing to the formation of Fe- and Ti-rich glass. The dark ejecta blankets run modern higher percentages of mare material with abundant Fe and Ti than the ejecta of Langrenus, which were derived from greater depths and should include more terra material. With time, subsequent impact comminution might therefore darken the ejecta of the small craters more rapidly than that of Langrenus.

GEOLOGIC HISTORY

The earliest discernible event in the Langrenus area was the formation of the Fecunditatis basin, probably among the oldest of the large multiring impact structures.

The terrae, perhaps once part of a Fecunditatis ring structure, are the oldest materials in the map area. Young ages for some lunar highlands craters (as after the area was the Cryptic impact for the north. Cayleyan ejecta likely mantled the highlands, forming the pre-Imbrian terra unit, and discrete blocks formed the chain of overlapping secondary craters southeast of Langrenus.

Plains, terra, and crater materials were formed in the early and middle parts of the Imbrian Period. Most mare materials probably are late Imbrian, but some subtrial flows, notably around Webb in the north-central part of the map area, may have formed in the Eratosthenian Period.

Cratering continued during the Eratosthenian and Copernican, the major Copernican event being the impact that created Langrenus and its secondary crater chains. Several impact craters, including the dark-halo craters, formed subsequently, and the topography has been continually degraded by bombardment and mass wasting.

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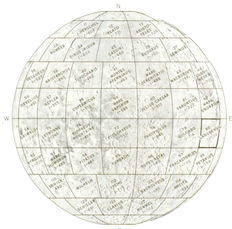
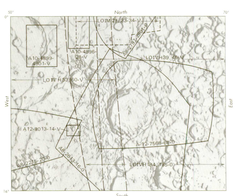


INDEX MAP OF THE EARTHSIDE HEMISPHERE OF THE MOON
Number above quadrangle name refers to lunar base chart (LAC series); number below refers to published geologic map.



PRINCIPAL PHOTOGRAPHIC COVERAGE OF LANGRENUS QUADRANGLE

Source and coverage of the available photographs are indicated. Roman numerals refer to Lunar Orbiter missions. Apollo mission numbers are prefixed by A. Arabic numerals after hyphen refer to individual frames or inclusive series of frames. photographs are vertical or oblique as indicated (V,O). Orbiter IV frame numbers refer to high resolution photographs (approx. 200 m for vertical frames, approx. 300 m for oblique); corresponding frames at moderate resolution cover entire lunar disk as seen from spacecraft. Orbiter I frames are moderate resolution (~85 m) for which no high resolution frames. Excellent Apollo photographs provide detailed stereoscopic coverage of craters Langrenus C, D, and Langrenus P and the crater ridge segments. On the western part of the map, Orbiter IV frames 39 and 40 are significantly degraded. Earth-based stereoscopic photographs of high quality cover the entire quadrangle.

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