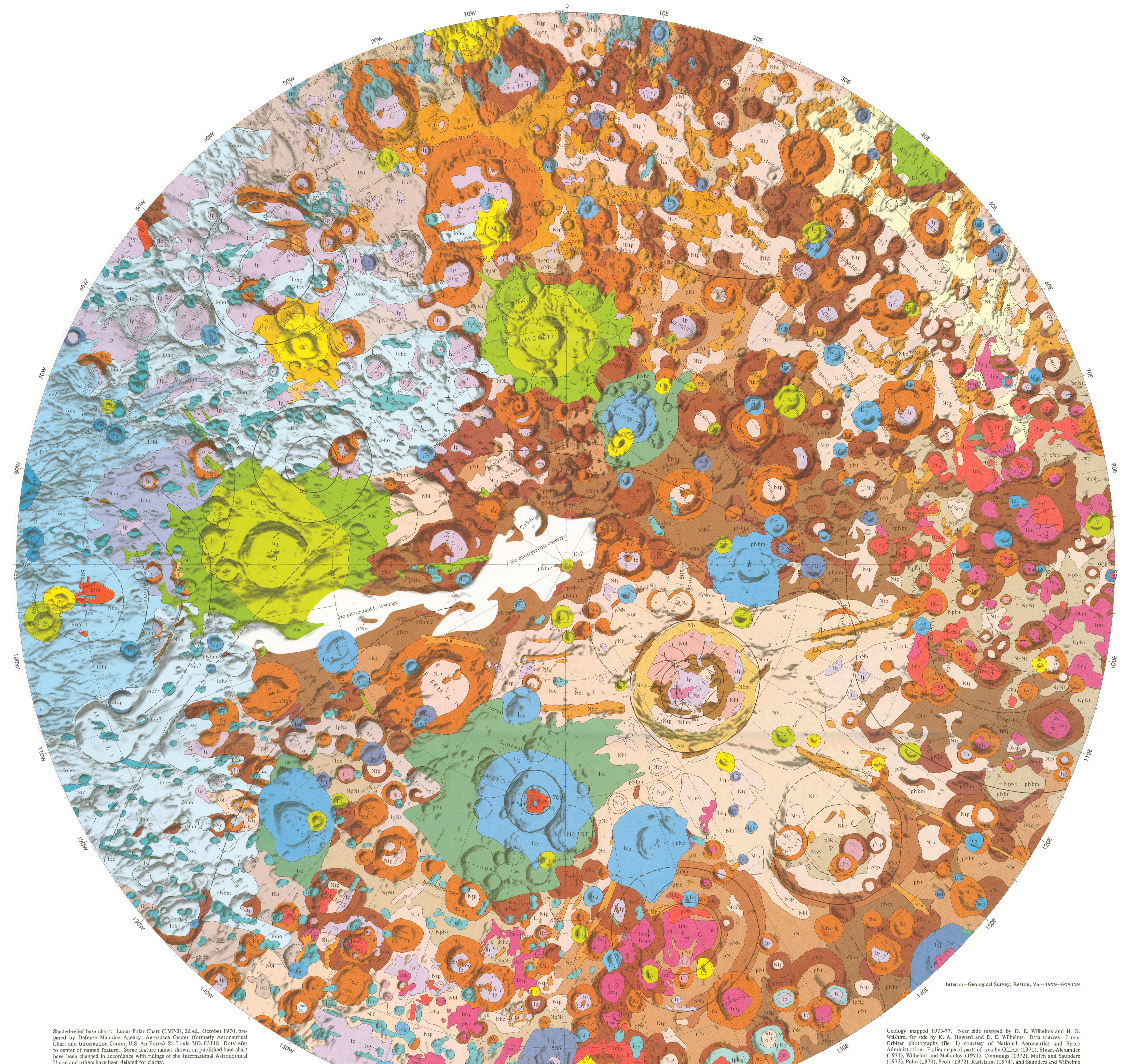
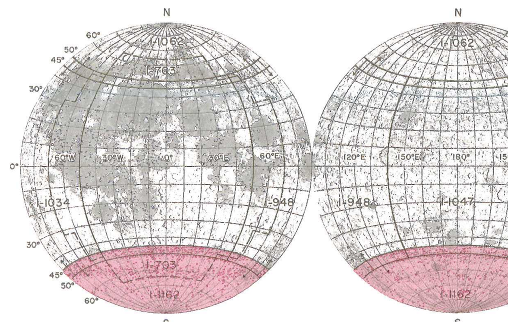
PREPARED ON BEHALF OF THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AND IN COOPERATION WITH THE
DEFENSE MAPPING AGENCY, AEROSPACE CENTER



Shaded-relief base chart: Lunar Polar Chart (LMP-3), 2d ed., October 1970, prepared by Defense Mapping Agency, Aerospace Center (formerly Aeronautical Chart and Information Center, U.S. Air Force), St. Louis, MO. 63118. Dots refer to center of named feature. Some feature names shown on published base chart have been changed in accordance with rulings of the International Astronomical Union and others have been deleted for clarity.

Geology mapped 1973-77. Near side mapped by D. E. Wilhelms and H. G. Wilshire, far side by K. A. Howard and D. E. Wilhelms. Data sources: Lunar Orbiter photographs (fig. 1) courtesy of National Aeronautics and Space Administration. Earlier maps of parts of area by Offield (1971), Stuart-Alexander (1971), Wilhelms and McCauley (1971), Cummings (1972), Mutch and Saunders (1972), Pohn (1972), Scott (1972), Karlstrom (1974), and Saunders and Wilhelms (1974). Prepared on behalf of National Aeronautics and Space Administration under Contract No. W-13,130.

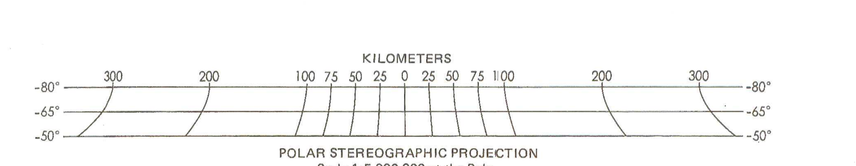
Interior—Geological Survey, Reston, Va.—1979—G79129



INDEX MAP OF THE MOON

The number preceded by I refers to published 1:5000000 geologic map.

I-703 Geologic map of the Near Side of the Moon (Wilhelms and McCauley, 1971)
I-948 Geologic map of the East Side of the Moon (Wilhelms and El-Baz, 1977)
I-1034 Geologic map of the West Side of the Moon (Scott and others, 1977)
I-1047 Geologic map of the Central Far Side of the Moon (Stuart-Alexander, 1978)
I-1062 Geologic map of the North Side of the Moon (Lucchitta, 1978)
I-1162 Geologic map of the South Side of the Moon



KILOMETERS

POLAR STEREOGRAPHIC PROJECTION
Scale 1:5 000 000 at the Pole

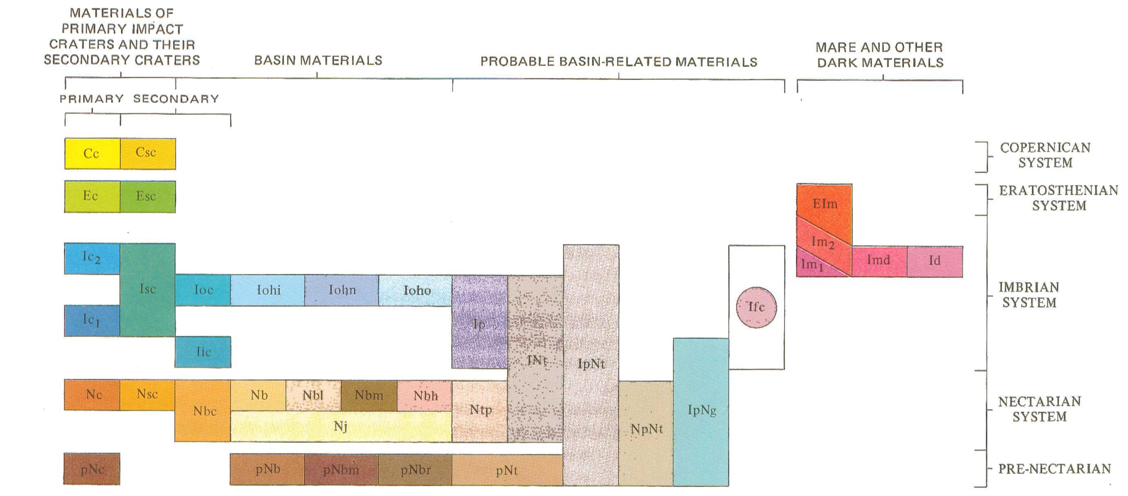
GEOLOGIC MAP OF THE SOUTH SIDE OF THE MOON

By

D. E. Wilhelms, K. A. Howard, and H. G. Wilshire

1979

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

MATERIALS OF PRIMARY IMPACT CRATERS AND THEIR SECONDARY CRATERS

Cc — YOUNGEST CRATER MATERIAL—Sharply textured and bright, mostly surrounded by bright rays

Csc — SECONDARY-CRATER MATERIAL

Ec — CRATER MATERIAL YOUNGER THAN MOST MARE MATERIAL—Similar to unit Cc but less sharp and bright; queried where could be unit Ic_2

Esc — SECONDARY-CRATER MATERIAL

Ic_2 — UPPER IMBRIAN CRATER MATERIAL—Younger than Orientale basin and part or all of unit Im_1, older than parts of unit Im_2; small craters lack fine textures, large craters have numerous small superposed craters; queried where could be units Ec, Ic_1, or Ioc

Ic_1 — LOWER IMBRIAN CRATER MATERIAL—Younger than Imbrium basin but older than Orientale basin; morphologically subdued, commonly difficult to distinguish from units Ic_2 and Nc

Isc — SECONDARY-CRATER MATERIAL

Nc — CRATER MATERIAL YOUNGER THAN NECTARIS BASIN BUT OLDER THAN IMBRIUM BASIN—Few rim or interior textures visible except in largest craters; queried where could be units pNc or Nbc

Nsc — SECONDARY-CRATER MATERIAL

pNc — CRATER MATERIAL OLDER THAN NECTARIS BASIN—Rim relief normally the only feature visible except in largest craters; queried where could be unit Nc

BASIN MATERIALS

ORIENTALE GROUP—Includes material of satellitic craters and Hevelius Formation

Ioc — MATERIAL OF ORIENTALE-BASIN SATELLITIC CRATERS—Grouped in clusters and chains peripheral to Orientale basin and in some outlying areas. *Interpretation:* Secondary impact craters of Orientale basin; queried where could be primary craters

HEVELIUS FORMATION—Divisible into inner, nonlineated, and outer facies

Iohi — Inner facies—Continuous deposit with ridges and grooves radial to Orientale basin centered north of area (concentric in crater Inghirami); thickly mantles subjacent cratered terrain. *Interpretation:* Ejecta of Orientale basin that flowed long distances along surface

Iohn — Nonlineated facies—Deposit with relatively smooth, wavy surface gradational with inner facies; forms raised lobes in places. *Interpretation:* Primary or secondary ejecta emplaced by fluidlike surface flow; may include impact melt

Ioho — Outer facies—Discontinuous deposits adjacent to Orientale secondary craters (mapped and unmapped) commonly having basin-radial ridges and grooves. *Interpretation:* Mostly ejecta formed by closely spaced secondary impacts

Iic — MATERIAL OF IMBRIUM-BASIN SECONDARY-IMPACT CRATERS—Similar to better developed secondary craters closer to Imbrium basin (Wilhelms, 1976); queried where could be primary craters

Nbc — MATERIAL OF NECTARIAN-BASIN SATELLITIC CRATERS—Grouped in clusters, chains, and groovelike chains mostly peripheral and approximately radial to Nectaris and other Nectarian basins; also includes more distant, radially oriented groups. *Interpretation:* Secondary impact craters of basin to which groups are radial or peripheral; origin of Humorum basin-radial groups at lat 56° to 64° S., long 0° to 30° E. and of queried groups doubtful

Nb — BASIN MATERIAL—Rim and wall material of double-ring basins. *Interpretation:* Impact materials formed near edge of excavated cavity

Nbl — BASIN MATERIAL, LINEATED—Lineated or otherwise textured material on basin flank. *Interpretation:* Basin deposits corresponding to Hevelius Formation of Orientale basin

Nbm — BASIN-MASSIF MATERIAL—Forms inner rings and parts of rim of basins. *Interpretation:* Blocks of crustal material uplifted during basin excavation

Nbh — HUMMOCKY BASIN MATERIAL—Hummocky terrain in floor of Schrödinger basin. *Interpretation:* Impact melt, perhaps draped over toes of slump structures (Howard and others, 1974)

Nj — JANSSEN FORMATION—Deposit around Nectaris basin similar to outer facies of Hevelius Formation. *Interpretation:* Ejecta of Nectaris-basin secondary impacts (includes primary ejecta north of mapped area)

pNb — BASIN MATERIAL, UNDIVIDED—Rim, wall, and inner-ring materials. *Interpretation:* Same as for corresponding features of Nectarian basins

pNbm — BASIN MASSIF MATERIAL—Large mountainous landforms commonly lying along arcs; gradational with generally finer topography of unit pNbr. *Interpretation:* Strongly uplifted parts of basin rims and inner rings

pNbr — BASIN MATERIAL, RUGGED—Forms diverse rugged, mostly elevated terrain; intermediate between unit pNbm and generally less rugged, lower unit pNt. *Interpretation:* Parts of South Pole-Aitken and Australe basins including main topographic rims, inner rings or other interior materials, and possible South Pole-Aitken ejecta near craters Clavius, Moretus, and Boussingault

PROBABLE BASIN-RELATED MATERIALS

Ip — PLAINS MATERIAL—Light-colored, smooth, mostly flat-surfaced deposits having superposition relations and crater densities indicating Imbrian age. *Interpretation:* Primary and secondary ejecta of Orientale and Imbrium basins and of craters

Ntp — TERRA-MANTLING AND PLAINS MATERIAL—Light-colored, wavy, rolling, or planar surfaces more heavily cratered than unit Ip. *Interpretation:* Primary and secondary ejecta of Nectarian basins and large craters equivalent to units Iohn, Ioho, and Ip, lacking their distinctive textures because of degradation by cratering or other aging processes

INt — TERRA MATERIAL—Moderate to weak smoothing of irregularities around Orientale basin; some basin-radial lineations and small pits like those of unit Ioho. *Interpretation:* Outer secondary deposits of Orientale basin superposed on deposits of Humorum (east) and Apollo (west) and on Nectarian craters

IpNt — TERRA MATERIAL—Similar to unit INt but slightly rougher, as includes more crater rims. *Interpretation:* Outer deposits of Orientale and Antoniadi superposed on pre-Nectarian craters

NpNt — TERRA MATERIAL—Diverse but mostly low-lying, smooth-appearing terrain gradational with lower and smoother unit Ntp and higher and rougher pre-Nectarian basin and crater materials. *Interpretation:* Probably composed of outer ejecta of Nectaris, other Nectarian basins, and crater Clavius, thinly mantling pre-Nectarian terrain; similar Nectarian material presumably superposed on adjacent mapped pre-Nectarian materials but not visible

pNt — TERRA MATERIAL—Forms moderately rugged to rugged, diverse terrain, including degraded partial crater rims and lower intervening tracts; gradational with lower and smoother unit NpNt and higher and rougher units pNbr and pNc. *Interpretation:* Degraded equivalents of Imbrian and Nectarian basin, terra, and plains materials and of younger crater materials

IpNg — GROOVED MATERIAL—Irregular grooves superposed on pre-Nectarian and Nectarian crater materials. *Interpretation:* Age of grooves uncertain but morphology suggests Imbrian; possibly produced by ejecta or seismic shaking from Imbrium basin impact

Ifc — FRACTURED CRATER FLOOR MATERIAL—Raised floors with fissures. *Interpretation:* Shrunken impact melt deposits or tectonically uplifted and dilated crater floors

MARE AND OTHER DARK MATERIALS

EIm — YOUNGEST MARE MATERIAL—Appears dark and lightly cratered. *Interpretation:* Basaltic lavas

Im_2 — INTERMEDIATE MARE MATERIAL—Similar in dark color and crater density to typical near-side mare material of late and middle Imbrian age. *Interpretation:* Basaltic lava; exact age range and composition unknown

Im_1 — OLDEST MARE MATERIAL—Light color and high density of superposed craters unusual for mare. *Interpretation:* Old basaltic lava, perhaps as old as Orientale basin

Imd — MARE DOME MATERIAL—Dark, smooth, slightly elevated terrain in maria. *Interpretation:* Basaltic intrusions or extrusions; queried where could be terra mantled by lavas or pyroclastic deposits

Id — DARK MANTLING MATERIAL—Halos around irregular craters along fissures in floor of Schrödinger basin. *Interpretation:* Thin pyroclastic deposits

Contact—Queried where inferred in poorly photographed areas

Crest of buried crater rim

Crest of basin ring structure—Dashed where poorly known

Fissure or narrow fault graben

Sinuous ridge

Sinuous scarp—Barb on uphill side

INTRODUCTION

This map of the lunar region below lat 45° S. is the sixth part of a complete geologic reconnaissance mapping of the Moon at 1:5000000 scale. The upper half of the map portrays the geology of the earth-facing or near side, and the lower half shows terrain that was unknown before spacecraft photography. The near side was well photographed at resolutions of 0.1 to 0.5 km by Lunar Orbiter IV, but coverage of the far side is of uneven quality (fig. 1). The geology of a small area near the south pole that was in shadow during the Orbiter missions can be partly inferred from the nature of adjacent units.

Mapping methods and conventions are not discussed in detail here because they are still perceived much as described earlier on a partly overlapping reconnaissance map (Wilhelms and McCauley, 1971). Many interpretations, however, have changed since preparation of that map. In particular, Apollo data indicate that terra (highland) volcanism is unimportant on the Moon and that most deposits of the terrae were emplaced by impact processes. This interpretation has influenced our delineation of some map units and their assembly into provinces on a summary map (fig. 2), which shows 16 ringed impact basins in and near the area, terra materials related or believed related to these basins, and volcanic mare materials that postdate the basins.

BASIN MATERIALS

Most lunar impact excavations larger than 260 km in diameter and some smaller ones possess one or more raised inner rings and so are called multiring basins (Hartmann and Kuiper, 1962). Other circular features this size and larger probably also originally had multiple rings, but the inner rings are now obscured. Many terra materials mapped here can be identified with specific basins, and the remainder are also believed related to basins or craters. Formation of two large, ancient (pre-Nectarian) basins (South Pole-Aitken and Australe) raised the highest mountains; three Nectarian basin impacts and the later Orientale basin impact outside the map area deposited extensive materials within it; and other pre-Nectarian, Nectarian, and Imbrian basins in and outside the area contributed to its geomorphic and stratigraphic framework.

RING IDENTIFICATION AND DATING OF BASINS

The largest and oldest basin so far documented on the Moon is South Pole-Aitken (Stuart-Alexander, 1978), also called Big Backside basin or Aitken-Backside basin. The basin rim is defined by a discontinuous mountain ring 2200 km (Stuart-Alexander, 1978) to 2500 km (this report) in diameter. The larger figure is based on an interpretation that massifs (map symbol pNbm) and adjacent rugged material (map symbol pNbr) between lat 75° S., long 40° W. and the unphotographed zone are part of the rim, and that other massifs and rugged material entirely on the far side constitute a second ring 250 to 500 km inside the rim. Alternatively, all the basin massifs and rugged basin material may constitute a very broad rim whose mean diameter would be about 2200 km. The rugged basin material as far north as lat 63° S. on the near side may also be part of the rim flank. The near-side massifs were discovered by Earth-based telescopic observations, and their connection with a large basin beyond the lunar limb was predicted by Hartmann and Kuiper (1962). The South Pole-Aitken basin is also expressed as a giant depression detected by Zond 6 and 8 photographic altimetry (Rodionov and others, 1971, 1977) and Apollo laser altimetry (Wollenhaupt and Sjogren, 1972; Bills and Ferrari, 1975; Kinsler and others, 1975). We estimate the basin center to be located at about lat 56° S., long 180°. Numerous small mare patches, partly localized in superposed basins and craters, occupy the basin inside the inferred inner ring.

At least four other basins centered in the map area are also pre-Nectarian in age. Planck, Poincaré, and Schiller-Zucchius ("basin near Schiller" of Hartmann and Kuiper, 1962) are small, double-ring basins identified as pre-Nectarian on the basis of degraded superposed craters. The fourth, Australe, is named for many small, discontinuous patches of mare material collectively known as Mare Australe. The circular pattern of the mare patches and an enclosing arcuate chain of massifs near long 120° E. led to recognition of Australe as a basin (Stuart-Alexander and Howard, 1970). This chain apparently indents the rim of South Pole-Aitken, a relation which suggests that Australe is the younger basin; exceptionally large massifs in this chain may have been uplifted by both impacts. Additional massifs and elevated tracts of rugged basin material and other units appear to define two interior Australe rings.

Four additional pre-Nectarian basins have been tentatively identified. A single ring about 700 km in diameter delineates a heavily cratered probable basin here named Mutus-Vlacq according to the convention of designating basins after superposed (unrelated) features (Wilhelms and El-Baz, 1977). This postulated rim accounts for small mounds of basin massif material (map symbol pNbm) and other elevated basinlike terrain (map symbol pNb) near lat 62° S., long 10° to 35° E., and the basin may have acted as a catchment for an otherwise puzzling concentration of Nectarian plains materials (map symbol Ntp). The smaller Sikorsky-Rittenhouse and Amundsen-Ganswindt basins show traces of inner rings (not mapped), but their identity as basins and their ages are uncertain because of burial by deposits from the Schrödinger basin. Parts of their postulated rings—especially those of Sikorsky-Rittenhouse ("unnamed A" basin of Hartmann and Wood, 1971, later withdrawn from the list of basins by Wood and Head, 1976)—could instead be part of the South Pole-Aitken basin. Finally, an indistinct possible basin named Pingré by Hartmann and Kuiper (1962) and Pingré-Hausen in this report underlies deposits of the crater Hausen and of the basins Orientale, Bailly, and Mendel-Rydberg.

Three basins centered in the map area are believed to be Nectarian in age—younger than the Nectaris basin and older than the Imbrium basin on the northern near side. The three differ greatly in degree of degradation. An indistinct, large basin, here named Mendel-Rydberg, was called the "SE limb basin" by its discoverers, Hartmann and Kuiper (1962), who identified on telescopic photographs two of the three rings mapped here. The nearby Bailly basin is smaller and younger. Both Bailly and Mendel-Rydberg are severely degraded as a consequence of burial by deposits from Orientale and the crater Hausen but are thought Nectarian in age because no pre-Nectarian craters appear to be superposed. The Schrödinger basin is younger still, and its deposits cover much of the map area. The density of superposed craters too small to map here (<20 km) suggests an age of late Nectarian, but this fresh-appearing basin could be lower Imbrian as no definite Nectarian craters are superposed. The inner ring consists of rugged crags similar to those of lunar central peaks (Hartmann and Wood, 1971) and is believed related in origin to such peaks although its exact formative process is uncertain (Hodges and Wilhelms, 1978). The other, terraced ring resembles the rims of craters (Howard and others, 1974, fig. 4) and must similarly be the limit of the excavated cavity modified by slumping.

INTERPRETATION OF CIRCUM-BASIN DEPOSITS AND SATELLITIC CRATERS

Deposits from basins centered outside the map area dominate more than half of its northern border zone. Emplacement processes of basin deposits have been deduced from the well-exposed, well-photographed Orientale materials. The inner facies of the Hevelius Formation (map symbol Iohi) is a continuous, strongly lineated, apparently thick deposit that extends back to the Orientale basin rim (Montes Cordillera) north of the region and that, accordingly, must contain much primary basin ejecta. This deposit apparently flowed along the surface at least part of the distance from the rim, for parts of it piled up as transverse ridges against the southeast wall of the crater Inghirami and other obstacles (McCauley, 1968; Scott and others, 1977). The relatively smooth, nonlineated facies of the Hevelius Formation (map symbol Iohn) is gradational with the coarsely textured inner facies and in part forms raised lobes bounded by distinct scarps (Moore and others, 1974, figs. 6,7) that suggest flowage of a viscous, fluidlike material.

Secondary impact apparently emplaced most deposits beyond the inner and nonlineated facies of the Hevelius Formation and beyond comparable, though less well preserved materials of other basins (Moore and others, 1974; Oberbeck and others 1974, 1975; Morrison and Oberbeck, 1975; Oberbeck, 1975; Wilhelms, 1976). Satellitic craters of Orientale (map symbol Ioc) so closely resemble secondary impacts of large lunar craters (Offield, 1971; Wilhelms and McCauley, 1971; Oberbeck and Morrison, 1974; Wilhelms, 1976) that their identity as Orientale basin secondaries seems certain. Basin-radial ridges and smooth deposits commonly lie on the distal side of the secondary craters and constitute a discontinuous unit called the outer facies of the Hevelius Formation (Scott and others, 1977); most of these deposits presumably consist of secondary ejecta. East of long 20° E. are corresponding, though less fresh, features of the Nectaris basin, including secondary craters (part of map unit Nbc) and ridged deposits (Janssen Formation, Stuart-Alexander, 1971). The Nectarian basin deposits (map symbol Nbl) and clustered secondary craters (map symbol Nbc) near the map border between long 142° and 176° W. are related to the Apollo basin centered 300 km north of the area. We have mapped the Apollo-related units as Nectarian based on their morphology but the basin may instead be pre-Nectarian (Stuart-Alexander, 1978).

Other probable secondary craters scattered throughout the map area, though not closely satellitic to basins, have been traced to their sources by orientation. Secondaries of Schrödinger (Nectarian) are easily identified as far as three basin diameters from its rim by linear, groovelike shapes and the concentration in few azimuthal directions that characterize this basin. A few probable Nectarian secondary craters in the vicinity of the Apollo deposits are more closely radial to the distant Hertzsprung basin, 1400 km north (lat 1° N., long 129° W.), than to Apollo. Numerous large chains east of the crater Clavius, also mapped as Nectarian basin secondaries, are radial to the distant Humorum basin (lat 24° S., long 39° W.) and may be parts of its secondary field although their nature is problematic. Finally, outliers of the large field of secondary impact craters of the Imbrium basin (map symbol Iic) occur in the north part of the map area.

PROBABLE BASIN-RELATED MATERIALS

Additional units interpreted as basin related occur among and beyond the secondary craters and lineated deposits. The inner, nonlineated, and outer facies of the Hevelius Formation grade in places into smooth-surfaced plains-forming material of Imbrian age that occupies depressions (map symbol Ip). Gradations of the smooth plains material with primary and secondary basin materials suggest that the plains material here consists of ejecta and not volcanic material, as has been proposed for some plains (for example, Wilhelms and McCauley, 1971; Neukum, 1977). Similar plains of Imbrian age that are distant from the Orientale basin may be ejecta of Imbrium-basin secondary craters or of large Imbrian primary craters. Nectarian terra-mantling and plains material (map symbol Ntp) is probably similar in origin to these Imbrian deposits, for it is concentrated around Nectarian basins (Nectaris, Schrödinger, Mendel-Rydberg, and Apollo), large craters (Clavius), and satellitic and distant secondary craters of Nectarian basins including those tentatively ascribed to Humorum. Age assignment of plains and terra-mantling materials depends partly upon crater counts made on photographs of uneven quality, so that some patches mapped as Nectarian could be older or younger, and some mapped as Imbrian could be Nectarian.

The outer facies of the Hevelius Formation grades outward into less heavily mantled terrain with fewer lineations and pits that is mapped as composite units—Imbrian and Nectarian terra (map symbol INt) where the units visible under the Orientale textures are mostly Nectarian, and Imbrian and pre-Nectarian terra (map symbol IpNt) where the underlying material is mostly pre-Nectarian. Much terrain outside the distinctive materials of Nectarian basins, though mostly lacking conspicuous lineations and pits, also seems subdued by a mantle that is gradational with the Nectarian basin materials and accordingly is mapped as Nectarian and pre-Nectarian terra (map symbol NpNt). Visibility of textures and therefore mapping of many lunar material units depend both on photographic quality and degree of degradation. For example, the outer facies of the Hevelius Formation and the Orientale-related composite units may be more extensive than mapped, especially on the far side where photographs are poorest. Also, time-related degradation has probably blurred Nectarian textures that once resembled those of Orientale, so that the well-defined basin-related province is less extensive relative to the probable basin-related province (fig. 2) for the Nectarian System than for Orientale. The degradation process has proceeded even further among pre-Nectarian units, where the rugged basin material (map symbol pNbr) and an even more poorly defined, generally low-lying unit called pre-Nectarian terra material (map symbol pNt) occupy the positions of the much more distinctive and varied younger basin units that they presumably once resembled. Contributions to the pre-Nectarian terra unit from the various pre-Nectarian basins and craters are not distinguished on this map because of inadequate photography and exposure.

Two more distinctive but less extensive units may also be related to basins although their origin is uncertain. The exposure of grooved material (map symbol IpNg) in the area near long 160° E. and the better exposures immediately to the north (Stuart-Alexander, 1978) are antipodal to the Imbrium basin and have been interpreted as the products of the impact of converging Imbrium ejecta (Moore and others, 1974) or shaking induced by seismic waves from Imbrium (Schultz and Gault, 1975). Most fractured crater floors (map symbol Ifc), the other areally restricted unit, are probably products of extensive floor uplift, a common phenomenon in and near basins (Pike, 1971; Schultz, 1976), but some peripheral to the Orientale deposits could be Orientale impact melt, as observed elsewhere in similar positions (Moore and others, 1974).

CRATER MATERIALS

Primary impact craters with a complete range in ages dot the map area, as they do all lunar highlands. The materials of these craters are still perceived much as described on earlier maps such as that by Wilhelms and McCauley (1971).

The unusual Imbrian crater Antoniadi (lat 69.5° S., long 172° W.), 150 km wide, deserves special mention for two reasons. First, it is ringed by an unusually extensive and dense array of secondary impact craters (map symbol Isc). Second, it has both a central peak and an inner ring of peaks, making it transitional between craters and multiring basins (Hartmann and Wood, 1971; Hodges and Wilhelms, 1978).

In summary, the geology of the terra can be accounted for by a succession of large and small impacts that excavated basins and craters, deposited the ejected material as a thick blanket near the rim crest, and flung it over a much wider distance where it cratered and redistributed the preimpact terrain. Basins were also favorable sites for subsequent internal activity, such as crater-floor uplift and mare volcanism.

MARE AND OTHER DARK MATERIALS

Although, in general, the near side of the Moon has more extensive mare material than the far side, the reverse is true in this southern area. Except near the east limb, that part of the near side within the map area is nearly devoid of mare material, whereas the far-side part contains dozens of mare patches. This concentration results from depressions afforded by the Australe and South Pole-Aitken basins and the smaller basins and craters superposed on them.

Three age groups of mare material have been mapped (two in fig. 2), each of which represents stratigraphically complex units with a range of ages. The oldest group (map symbol Im_1) was early recognized as exceptionally old for lunar mare material (Stuart-Alexander and Howard, 1970). It is older than many upper Imbrian crater materials (map symbol Ic_2) and than all known mare materials of the central near side. It is lighter in color than most other mare units and is gradational in color and crater density with the terra and plains materials. The intermediate mare material mapped here (map symbol Im_2) substantially overlaps typical near-side mare material in age, although its full age range has not been determined. The distinction between mare units is clear over most of Mare Australe but can be made only tentatively in the poorly photographed area in the South Pole-Aitken basin. The youngest unit (map symbol EIm) is partly or entirely Eratosthenian. Small mare domes (map symbol Imd) and similar swellings that may be domes or mantled terra (map symbol Imd?) also are mapped, as are small patches of dark mantling material (Id) surrounding their apparent source vents in the Schrödinger basin.

A few large wrinkle-ridge structures traverse part of Mare Australe but wrinkle ridges and fault grabens are rare in the map area, in contrast with their abundance in and near the large nearside lunar maria. This distribution supports an inference that most nonimpact compression and extension of the lunar crust relate to crustal loading by mare basalts (Solomon and Head, 1979).

GEOLOGIC HISTORY

The detectable history of the region begins with the largest event inferred from visible landforms on the Moon, the impact that raised the massive South Pole-Aitken rim, excavated most of the far-side part of the map area, and probably covered the near-side part with excavated debris. A second large impact formed the adjacent Australe basin, and smaller pre-Nectarian impacts excavated at least three basins (Poincaré, Planck, and Schiller-Zucchius), possibly four others tentatively identified, and perhaps still others that have been obscured. The Nectarian Period began with the formation of the Nectaris basin, which is centered outside the map area but strongly influenced it by covering and cratering many pre-Nectarian craters and basin deposits. Later in Nectarian time, the Apollo and Humorum impacts also deposited materials and formed secondary craters in the north part of the area, and the Mendel-Rydberg, Bailly, and Schrödinger basins and the large crater Clavius were formed within it. Schrödinger, with its distinctive, linear secondary-crater chains and pronounced double-ring structure, strongly affected the appearance of the southern far side. In the Imbrian Period, ejecta from the distant Imbrium basin formed scattered secondary craters, Orientale basin deposits blanketed a huge region on the west limb including the Mendel-Rydberg and Bailly basins, and Orientale ejecta formed many secondary craters beyond this blanket. Mare volcanism left still-visible traces in the lowlands of the South Pole-Aitken and Australe basins beginning about the time of the Orientale impact, continuing through the Imbrian Period, and locally extending into the Eratosthenian. Impact events, which in Imbrian time produced the crater-basin Antoniadi and other large craters, continued at a low rate through the Eratosthenian and Copernican Periods.

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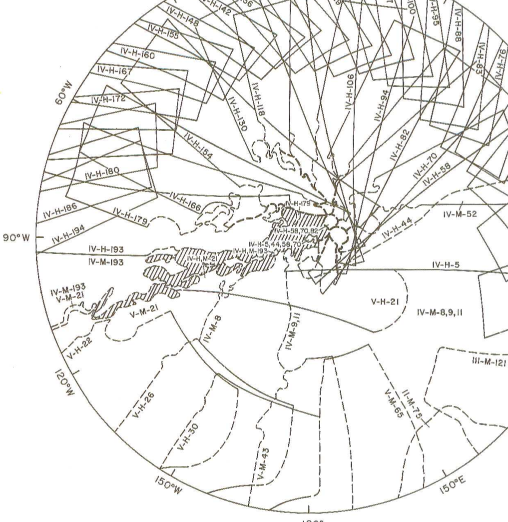

EXPLANATION

IV Lunar Orbiter mission
H High resolution
M Moderate resolution
38 Frame number
Frame boundary
Terminator or other approximate limit of useful coverage within frame
Common limit of two or more frames
No photographic coverage

FIGURE 1.—Index map showing photographic coverage. Nearly complete coverage is provided by Lunar Orbiter IV moderate-resolution frames 8, 44*, 52, 94*, 130*, 166*, and 193, and by Lunar Orbiter V moderate-resolution frames 21, 22*, 26*, 30*, 43, and 65. Soviet Zond spacecraft photographs (Rodionov and others, 1971, 1977) were not available.
* Not plotted; covers large area centered on corresponding high-resolution frame.

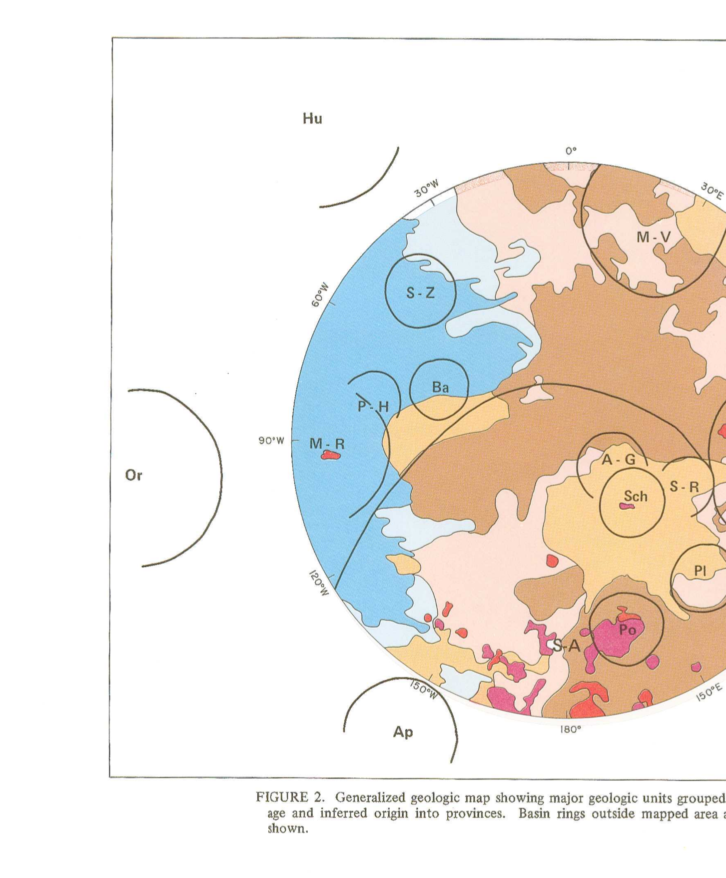

FIGURE 2. Generalized geologic map showing major geologic units grouped by age and inferred origin into provinces. Basin rings outside mapped area also shown.

EXPLANATION

MARIA — Upper, younger; Lower, older

ORIENTALE BASIN — Dark, well-defined basin materials including Hevelius Formation and large secondary craters; Light, probable additional Orientale deposits overlying older terrain

NECTARIAN BASINS — Dark, well-defined basin materials including Janssen Formation, material of Schrödinger, Apollo, Mendel-Rydberg, and Bailly basins, and large secondary craters; Light, probable additional Nectarian basin deposits overlying older terrain

PRE-NECTARIAN BASINS AND LARGE CRATERS

Province boundary—Dashed where buried by younger province

Main topographic rims of basins in and near region covered by geologic map; basin abbreviations:

A-G	Amundsen-Ganswindt	M-V	Mutus-Vlacq	S-R	Sikorsky-Rittenhouse
Ap	Apollo	Ne	Nectaris	S-A	South Pole-Aitken
Au	Australe	Or	Orientale	Sch	Schrödinger
Ba	Bailly	P-H	Pingré-Hausen	S-Z	Schiller-Zucchius
Hu	Humorum	Pl	Planck		
M-R	Mendel-Rydberg	Po	Poincaré		

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