EXPLANATION FOR PRELIMINARY GEOLOGIC MAP OF THE APENNINE REGION OF THE MOON

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

For the purpose of geologic mapping a classification has been adopted in which map units are grouped according to sequence or relative age. The major divisions of this classification are called systems (Shoemaker, 1961; Shoemaker and Hackman, 1962) and subdivisions of the systems are called series. The systems and series are arranged below in the order of relative age, the youngest at the top and oldest at the bottom.

Each system or series corresponds to a period or epoch whose salient events are listed on the table below:

Period	Epoch	Events
Copernican		Formation of ray craters
Eratosthenian		Formation of craters of which rays are no longer visible
Procellarian		Extensive deposition of mare material
Imbrian	Archimedian	Formation of pre-Procellarian, post-Apenninian craters
	Apenninian	Events related to the formation of the Mare Imbrium basin
pre-Imbrian time		Not yet formally divided

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

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

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

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

A question mark before a crater label (for example, ?Cs) implies that the existence of the crater is questionable. A question mark after the crater label (Ir?) implies that the stratigraphic designation is questionable.

References cited

Shoemaker, E. M., 1962, Interpretation of lunar craters, in Kopal, Zdenek, ed., Physics and Astronomy of the Moon: London, Academic Press, p. 283-359.

Shoemaker, E. M., and Hackman, R. J., 1962, Stratigraphic basis for a lunar time scale, in Kopal, Zdenek, and Mikhailov, Z. K., eds., The Moon--Symposium of the International Astronomical Union: London, Academic Press, p. 289-300.

COPERNICAN SYSTEM

Ray material

(Discontinuously distributed ejecta) from primary and secondary craters)

Telescopic characteristics

Reflectivity generally high but grades to that of surrounding material. Local contrast in reflectivity generally large; lateral variations locally abrupt; characterized by bright patches and streaks. Ray material is superimposed on parts of all other units.

Interpretation

Probably chiefly crushed rock. Forms thin patchy layers, in most places probably not more than a meter thick.

Cr | Crd

Crater rim material

(Ejecta blanket)

Telescopic characteristics

Reflectivity moderate to very high. Local contrast in reflectivity moderate to large; lateral variations commonly abrupt. Areas of relatively low reflectivity around larger craters mapped as Crd . Topography around large craters is hummocky near crest of rim and includes low hummocks or low subradial ridges around flanks. Around small craters topography is smooth. Crater rim material grades to ray material away from craters.

Interpretation

Probably chiefly crushed rock with large blocks. Forms hummocky layers ranging from about a meter to about 700 meters in thickness.

Cs

Slope material

(Talus?)

Telescopic characteristics

Reflectivity high to very high. Occurs mostly on smooth slopes ranging from 20° to 40°

Interpretation

Probably partially sorted fragments ranging in size from dust to large blocks

Cf

Crater floor material

(Breccia?)

Telescopic characteristics

Reflectivity generally high to very high. Local contrast in reflectivity moderate; lateral variations generally abrupt. Topography generally smooth or flat in craters less than 16 kilometers across but partly flat and partly hilly to entirely hilly in larger craters

Interpretation

Probably chiefly crushed rock with large blocks. Probably forms deep lenses inside craters.

Rill and chain-crater material

Telescopic characteristics

Material of generally low to moderate reflectivity lying within narrow linear depressions with associated small craters or within linear series of craters

Interpretation

Probably includes breccia, fault blocks, and volcanic rocks. Age not definitely established but probably chiefly Eratosthenian

Cc

Copernican satellitic craters
(Secondary impact craters?)

Telescopic characteristics

Small relatively shallow craters occurring in rim material and rays around large Copernican craters. Satellitic craters are commonly composite or elongate with very low rims or no observable rims. All satellitic craters closely associated with ray material have been mapped as Copernican in age. Some so designated may be older

Interpretation

Craters formed by impact of fragments ejected from large, primary craters

ERATOSTHENIAN SYSTEM

Elr

Crater rim material

(Ejecta blanket)

Telescopic characteristics

Reflectivity low to moderate. Local contrast in reflectivity small to moderate; lateral variations generally gradual. Topography in southwest corner of region on rim flank of Eratosthenes (a crater southwest of the region) includes low subradial ridges. Elsewhere topography is smooth.

Interpretation

Probably chiefly crushed rock with large blocks. Forms hummocky layers ranging from about a meter to 150 meters in thickness

Elf

Crater floor material

(Breccia?)

Telescopic characteristics

Reflectivity low to moderate. Local contrast in reflectivity small. Topography generally smooth or flat

Interpretation

Probably chiefly crushed rock with large blocks. Probably forms deep lenses inside craters

Ec

Eratosthenian satellitic craters
(Secondary impact craters?)

Telescopic characteristics

Small relatively shallow craters occurring in rim material of, and in region surrounding rim of, Eratosthenes (a crater southwest of region). Satellitic craters are commonly composite or elongate, with very low rims or no observable rims

Interpretation

Craters formed by impact of fragments ejected from Eratosthenes

PROCELLARIAN SYSTEM

Pd

Dome material

Telescopic characteristics

Reflectivity low and local contrast in reflectivity small. Forms domes up to 55 kilometers across and up to about 300 meters high

Interpretation

Probably chiefly volcanic flows; may include volcanic ash. Common low reflectivity and low slopes suggest dominantly basaltic composition

Pm

Mare material

Telescopic characteristics

Reflectivity generally low with small local contrast and gradual to abrupt lateral variations. Forms extensive, relatively smooth horizontal surfaces abruptly terminated against many topographic forms

Interpretation

Probably volcanic flows. Great extent and relatively smooth topography suggest thick sheets of basalt or ignimbrite. Forms layers ranging in thickness from zero to a few thousand meters

Ac

Archimedian satellitic craters
(Secondary impact craters?)

Telescopic characteristics

Small, relatively shallow craters occurring in rim material of, and in region surrounding rim of Archimedes. Satellitic craters are commonly composite or elongate, with very low rims or no observable rims

Interpretation

Craters formed by impact of fragments ejected from Archimedes

IMBRIAN SYSTEM

Archimedian Series

Iar

Crater rim material

(Ejecta blanket)

Telescopic characteristics

Reflectivity low to moderate. Local contrast in reflectivity small to moderate. Lateral variations generally gradual. Topography is hummocky near crest of rim and includes low hummocks or low subradial ridges on rim flanks

Interpretation

Probably chiefly crushed rock with large blocks. Forms hummocky layers ranging from about a meter to about 600 meters in thickness

Apenninian Series

Ir | Ird

Regional material

(Ejecta blanket)

Telescopic characteristics

Reflectivity ranges from very low to moderate with generally moderate local contrast and gradual lateral variations. Ird has much lower reflectivity than Ir . Topography is generally rough throughout map area with exception of a few low areas of lesser relief

Interpretation

Probably chiefly crushed rock and great blocks derived mainly from the region of Mare Imbrium. Forms a layer probably ranging from a few meters to about 1000 meters in thickness. Layer is probably heterogeneous in composition. Areas where Apenninian layer may be generally very thin and pre-Imbrian material locally exposed are shown with ruled pattern.

Contact

Dashed where approximately located

Indefinite contact

(Pm)
(Ir)

Concealed contact

Offset of surface
(Fault)

Showing foot of scarp separating regions of similar topography

U, upthrown side; D, downthrown side

Dotted where partly or completely covered, but inferred from topography

Lineament
(Probable fault or fracture)

Partially or completely covered. Inferred from linear topographic features

Mare ridge

Showing crest line. Tapered end indicated by arrowhead. Queried where probable. Probably underlain by anticline; possibly the site of a volcanic extrusion.

Mare trough

Showing trough line. Tapered end indicated by arrowhead. Queried where probable. Probably underlain by syncline

Rounded mare scarp

Showing trace of foot of scarp. Barbs point in direction of slope. Queried where probable. Probably a flow front or monocline

Outer limit of telescopically observable low hummocks or low subradial ridges on Copernican crater rim material