DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
MANNED SPACECRAFT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GEOLOGIC ATLAS OF THE MOON
TAURUS-LITTROW-APOLLO 17
I-800 (SHEET 1 OF 2)

GEOLOGIC SUMMARY

INTRODUCTION

The Taurus-Littrow region is mainly a highland area at the juncture of Mare Serenitatis and Mare Tranquillitatis (Scott and Pohn, 1972). Highland materials cover most of the area, forming a group of rugged massifs close to the center of the map and more subdued terrain to the east. The highland units (pItm, IpIh) are probably mostly breccias formed by the Serenitatis impact and pre-existing breccias excavated by this event. Younger Crisium and Imbrium ejecta may also be present but cannot be distinguished. To the west and southwest materials typical of lunar maria, almost certainly basalts, encroach upon and embay the highland terrain. Also in the west is a unit of special interest, a relatively young, unusually dark material that mantles both terra and mare. It is draped over a wide variety of terrains in much of the western half of the map area and is interpreted as pyroclastic volcanics. The Apollo 17 site lies on this dark mantling material where it covers an embayment of mare materials between upland massifs. At this locality, therefore, relatively young volcanics can be sampled as well as the ancient deposits that form the highland massifs.

STRATIGRAPHY

The oldest units in the area are the massif materials (pItm) and the hilly terra material (IpIh). These two occur in a similar structural position—on the rim of the Serenitatis basin—and they are probably very similar in lithology and composition, being largely Serenitatis breccias with a covering of breccias derived from younger more distant basins. They are assigned different ages because of their structural history. The massif material is exposed in rugged, uplifted, crustal blocks around the landing site. Uplift has brought close to the surface deep, old, material that may be incorporated into the talus that surrounds the massifs. In the more subdued hilly terrain, the older, deeply buried rocks are less likely to be a significant component in the surface rocks, hence the younger age. The geologic setting of the massifs is similar to that of the Apennine Mountains at the Apollo 15 site (Carr and others, 1971). Like the Apennine Mountains, the massifs probably consist of interbedded breccias derived from the adjacent basin (LSPET, 1972). Some of the massifs resemble terrestrial domes formed by shallow intrusion or extrusion of silicic igneous rocks, but this origin is considered unlikely. The characteristic appearance of the hilly terra unit is believed to result from its deformational history and not from any distinctive lithology. Like the massif materials, it probably consists of interbedded breccias but with a larger component of post-Serenitatis breccias exposed at the surface than in the case of the massifs.

Plains material (Ip) is exposed around the outer edge of the Serenitatis basin, where it forms series of benches that stand slightly above the adjacent mare plains. The material also occurs within the highlands, partly filling irregular depressions and craters. The origin of the unit is uncertain. The flat, smooth, mare-like surface suggests emplacement in a fluid state and hence a volcanic origin. Materials of similar appearance at the Apollo 16 site were found, however, to be breccias. The plains material may therefore be of diverse origin, being volcanic in places, particularly around the edge of the Serenitatis basin, and consisting of fluidized impact debris in other areas.

The terra unit (It) is transitional in appearance between the plains and hilly terra materials. It may not be a separate stratigraphic unit but is mapped in areas where the plains material is thin or only partly covers the underlying hilly area.

Mare materials (Im, Em) are assigned different ages largely on the basis of albedo, since elsewhere on the Moon dark mare commonly has fewer craters than light mare. In albedo and crater density, unit Im is similar to the Apollo 11 basalts; unit Em is similar to the Apollo 15 basalts, and corresponding ages are likely. Where a cover of dark mantling material (Cd) precludes the distinction between mare and plains units, the unit mare or plains material (Imp) is mapped instead.

Except for ejecta from late Copernican craters (Cc_6, Cc_5), the youngest materials in this region, and possibly on the Moon, are the bright and dark mantles. The bright mantle material (Cb) lies at the base of a massif and extends several kilometers across a relatively flat valley floor. The high albedo, low intrinsic relief, and hummocky, ridged texture on the surface are all suggestive of a debris flow, or landslide, originating from the talus around the massif. In most places the unit is clearly younger than the dark mantle since the bright albedo has not been masked. In other places, however, the hummocky surface texture of the bright material appears to extend beneath the dark mantle and the normally high albedo of the slide becomes subdued. This suggests that the dark material, and possibly the slide itself, was deposited intermittently so that the two units interfinger. Although the emplacement of the slide was a relatively late event, the radiometric age of most of the material that constitutes the slide should be old ($>4.0 \times 10^9$ yrs) and comparable to the materials from the massif.

The age of the dark mantle was estimated by determining the frequency distribution of superposed craters in various size ranges. An upper limiting crater diameter for the steady-state distribution was obtained, the limit being a function of the age of the surface (Morris and Shoemaker, 1968). The results indicate that the dark mantling material is no older than the rim material of Tycho, where this type of study was applied to Surveyor VII data. Since the age of Tycho is estimated to be 0.50×10^9 yrs (Soderblom and Lebofsky, 1972), the dark mantling material appears to be considerably younger than any unit yet sampled in the Apollo program. This young age is not, however, entirely consistent with the stratigraphic relations. In areas other than the landing site, particularly in the northwest corner of the map and in the Sulpicius Gallus region (Carr, 1966), very similar material appears to be older than the mare surface. This suggests that deposition of the dark mantling material could span a considerable length of time.

The prominent dark crater near the northeast margin of the bright mantle may be a volcanic vent and the source of some of the most recent dark material. Alternatively, the crater may have been formed by impact and its rim and walls darkened by ejecta from the subjacent dark mantle. Many smaller dark craters, thought to be volcanic vents, are scattered throughout the mare and highland region. Some of these are mapped, but many are too small to be readily discernible or are obscured by the dark mantle.

STRUCTURE

The dominant structural pattern in the eastern half of the map area is one of intersecting northeast- and northwest-trending fractures of the lunar grid (Strom, 1964). They give much of the terrain its knobby appearance. The fractures appear to be largely pre-Imbrian since they only minimally affect the Imbrian plains materials. In the eastern half of the map, structures related to the Serenitatis and Imbrium basins are the most prominent. The massifs around the landing site have more relief than any other part of the Serenitatis rim except that adjacent to the Imbrium basin. The relief is believed to result from re-activation and uplift along Serenitatis radial fractures during the formation of the Imbrium basin. This is the only part of the remaining Serenitatis rim where the Serenitatis and Imbrium radials are parallel, so that re-activation is probable. (The re-entrant in which the landing site lies is elongate radial to both Imbrium and Serenitatis). Prominent also are structures concentric with the Serenitatis basin, the most obvious being the Littrow rilles. Two sets of rilles are recognized. The first occurs in the unit (Ip) and is embayed by and hence predates the mare (Im); the second set, which is made up of narrower more fresh appearing rilles, cuts and hence postdates the mare.

GEOLOGIC HISTORY

The primordial lunar crust of the region was covered during early pre-Imbrian time by ejecta from several large impact basins such as Tranquillitatis, Fecunditatis, and Nectaris. Most of the upland material presently close to the surface is, however, probably ejecta from the adjacent Serenitatis basin. The original surface texture of the Serenitatis ejecta blanket has been completely destroyed by erosion and fracturing. Formation of the two closest post-Serenitatis basins, Crisium and Imbrium, may have resulted in deposition of an additional younger veneer of ejecta over the area, but this is not detectable in the photography. Locally, the main effect of the Imbrium event was to cause uplift of the massifs around the landing site. After the Imbrium basin formed, or parhaps even earlier, the basin began to fill with mare basalts, and this may have continued throughout the Imbrian period. Several episodes of faulting along fractures concentric with the Serenitatis basin resulted in the formation of some of the Littrow rilles during this period. Most of the mare deposition terminated at the end of the Imbrian period, but some mare basalts were deposited in later Eratosthenian time in the southern part of the area. Faulting concentric to the Serenitatis basin also continued into post-Imbrian time to form the youngest of the Littrow rilles. The final major event in the geologic history of the area was deposition of the dark mantling material over much of the upland and mare.

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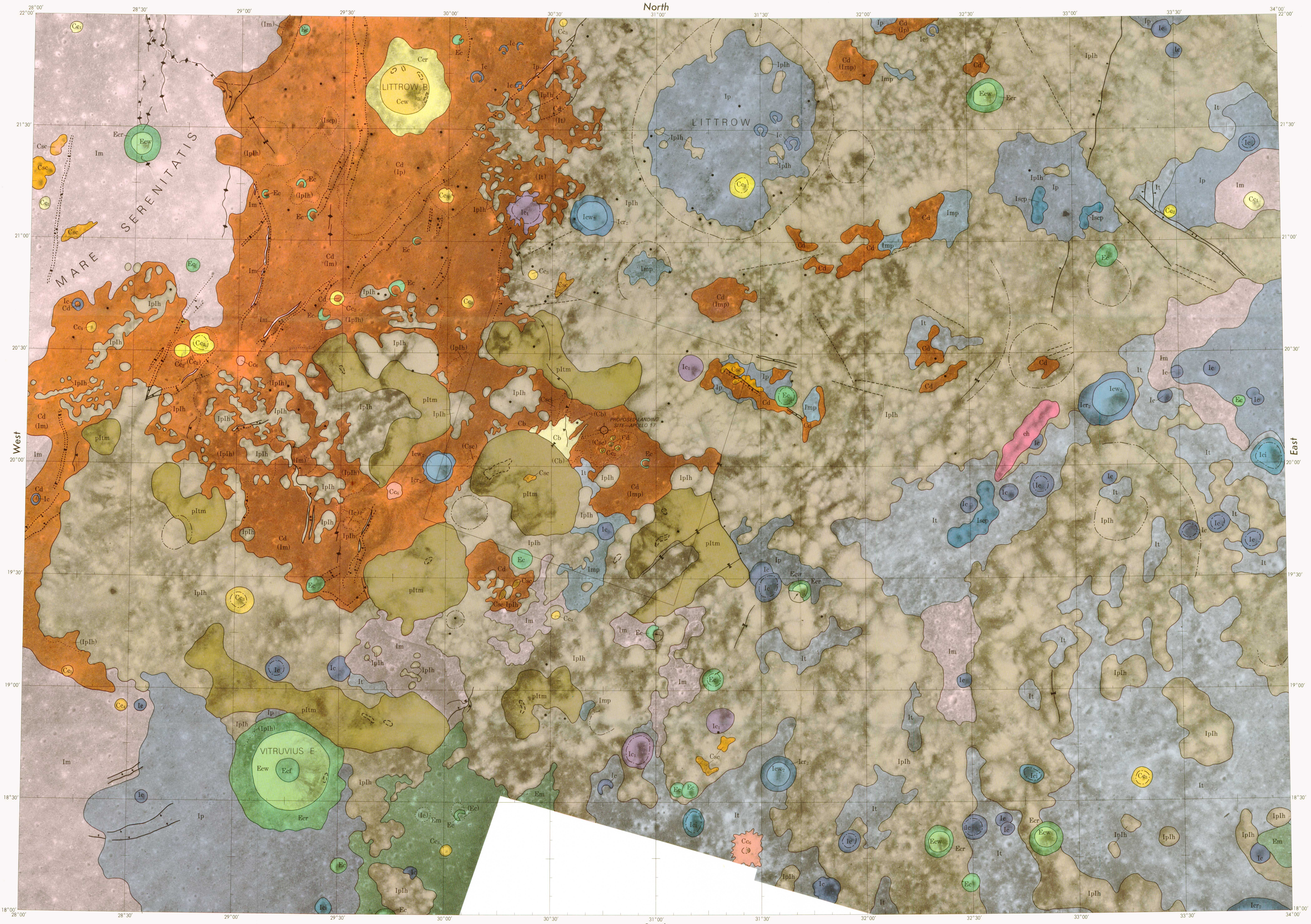

Base map from controlled mosaic of Apollo 15 metric photographs AS15-0968, 0970, 0972, 0974, 1655 and 1657, prepared by U.S. Topographic Command under direction of Department of Defense for National Aeronautics and Space Administration, July 1972.

SCALE 1:250,000
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Principal sources of geologic information: Apollo 15 metric photographs AS15-0392, 0393, 0564, 0971, 0972, 0973, 1111, 1112, and 1113; Apollo 15 panoramic photographs AS15-9286-9300 and 9546-9565; Lunar Orbiter V medium resolution photographs M66-69 and high resolution photographs H66-69; Full-Moon photograph 5818 from U.S. Naval Observatory, Flagstaff, Arizona. NASA contract No. T-5874A

GEOLOGIC MAP OF THE TAURUS-LITTROW REGION OF THE MOON

APOLLO 17 PRE-MISSION MAP

By
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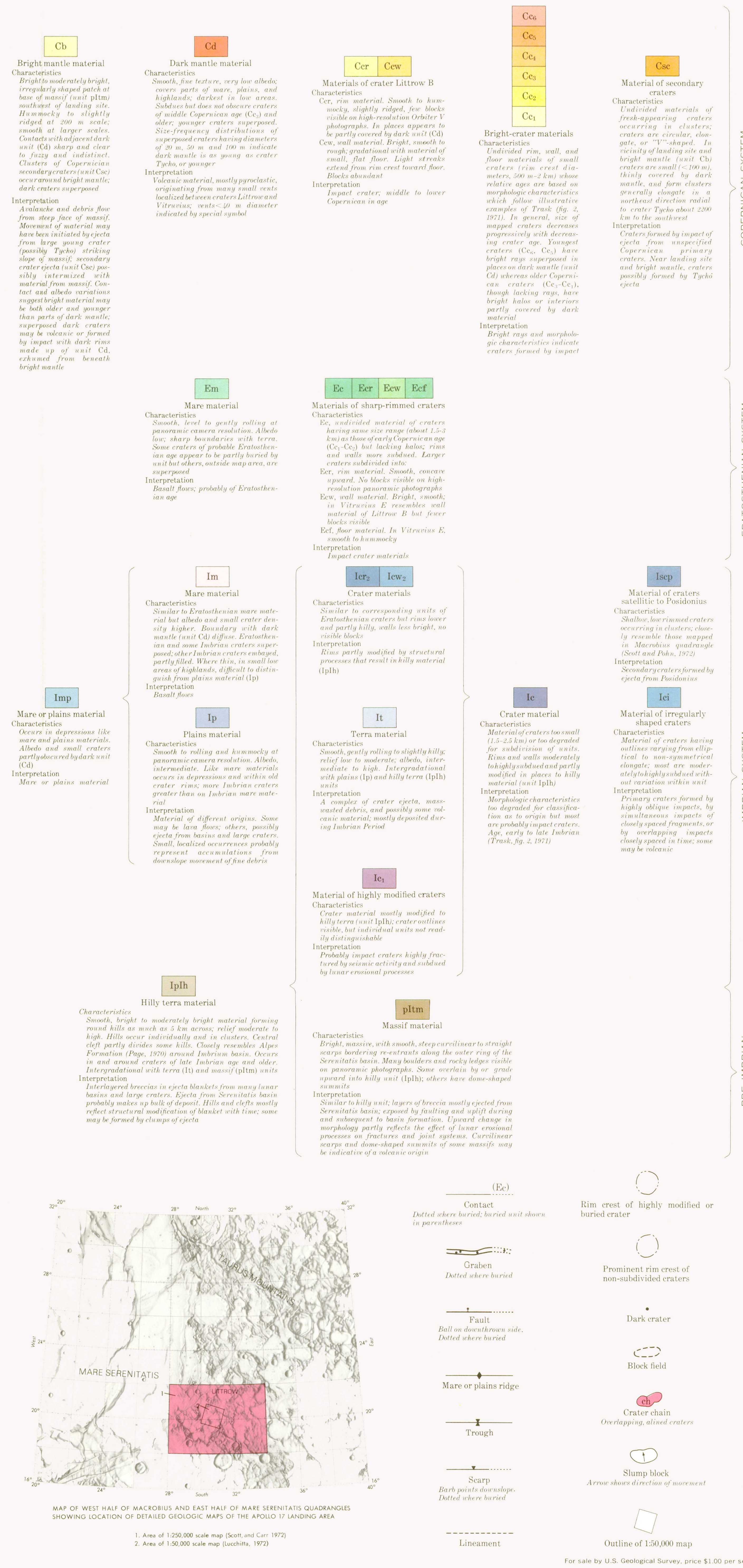
1972

EXPLANATION



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