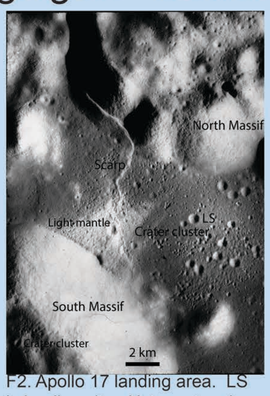
APOLLO 17 GEOLOGIC MAPS: WHAT WE KNEW THEN.

B. K. Lucchitta, U. S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ 86001. blucchitta@usgs.gov.

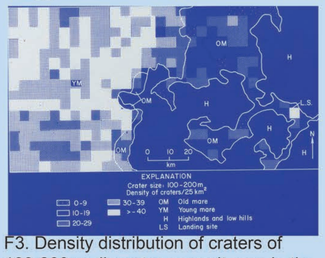
49th LPSC
Abstract #1573

F1.Taurus Littrow Region. Landing site at LM in center right. Note light Mare Serenitatis, and dark mantle on old mare near Rima Littrow. From [4]. Metric camera AS17-0557.

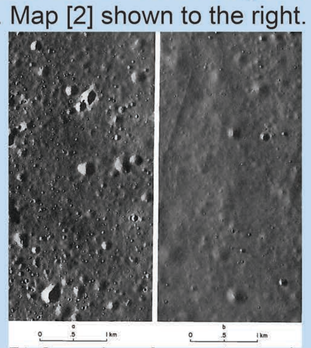


F2. Apollo 17 landing area. LS is landing site. Note crater cluster on top of South Massif. Ap 17 pan camera photo 2309.

Introduction: The objectives of the Apollo 17 mission were to understand the structural setting of the site on the rim of the Serenitatis basin (F1) and the composition and age of the highlands. Also of interest was the valley floor, which appeared overlain by exceptionally dark and bright materials (F2). To this end, two geologic maps at scales 1:250,000 [1] and 1:50,000 [2] were prepared. They reflected our understanding of the geology of the Moon at the time. Map [2] shown to the right.

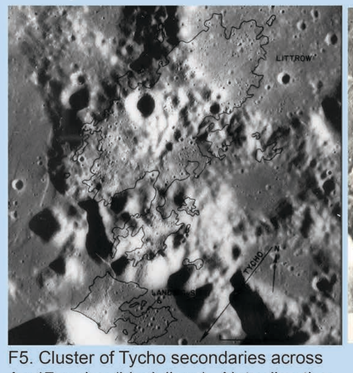


F3. Density distribution of craters of 100-200 m diameter per unit area in the Taurus Littrow region. Note high crater density in young mare YM, and low density in old mare OM, leading to wrong age assignments. Landing site at L.S. From [14].



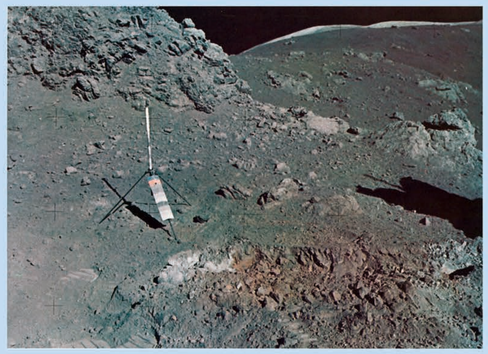
F4. Comparison of apparent crater densities. Young mare on left, old mare with dark mantle on right. Note subdued craters in mantled old mare. From [14].

Premission: *Highlands.* The Apollo 17 site lies within a graben radial to the Serenitatis impact basin and is bordered by high "*massifs*" (F1,2) thought to have been uplifted after the impact event [4]. The massifs are bordered by rounded domes of the "*sculptured hills*"; both were interpreted to be ejecta composed of breccia [3]. The "*plains*" of the valley floor (F2) were considered to be either a veneer of ejecta on underlying lava, or ejecta filling the entire trough. A "*dark mantle*" of exceptionally low albedo was thought to be young and of possible pyroclastic origin [1,2] because it apparently draped over and subdued young craters (F3,4). Also, crater counts suggested an age possibly as young as the crater Tycho [5] (F8,9). However, young mare of the Serenitatis basin locally embayed the dark mantle [6], inserting ambiguity into the age assignment. Fresh "*bright material*" at the base of the South Massif (F2) likely was an avalanche derived from the massif. A fresh-looking "*crater cluster*" south-east of the landing site (F2) was tentatively determined to be secondaries from Tycho.



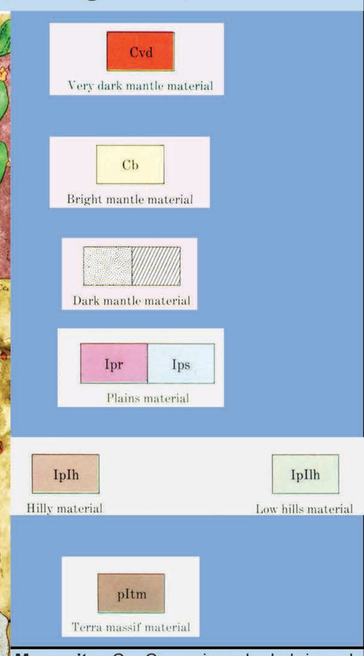
F5. Cluster of Tycho secondaries across Ap 17 region (black lines). Note direction to Tycho. Ap 17 site at center bottom. From [15].

F6. Sulpicius Gallus dark-mantle region on the SW rim of Serenitatis. Arrows point to small craters with orange or red ejecta, identified on orbital Hasselblad color photographs. From [10].



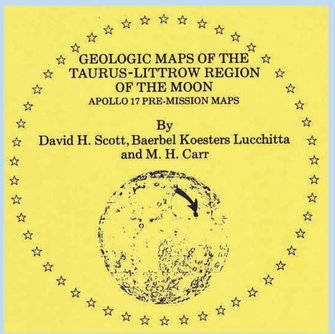
F7. Orange soil on rim of Shorty crater. NASA Apollo 17 EVA photo, press release.

Map modified from Lucchitta B. K. (1972) USGS Misc. Geol. Inv. Map I-800, sheet 2. Original scale 1:50,000.

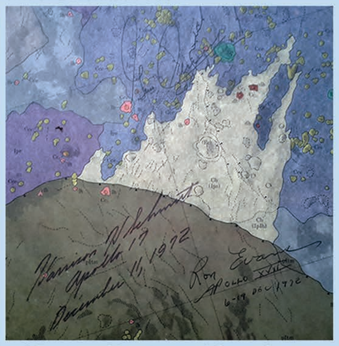


Map units. C = Copernican, I = Imbrian, pI = pre-Imbrian. Disclaimer: fuzziness is from poorly scanned archival map.

Craters on map. Yellow = Copernican, green = Eratosthenian, blue = Imbrian.



Cover of USGS Misc. Geol. Inv. Map I-800, 2 sheets. Gives location on SE rim of Serenitatis basin.



Cool Factor: Signatures of Gene Cernan, Ron Evans, and Harrison (Jack) Schmitt.

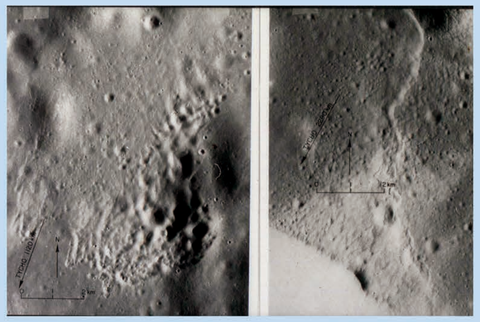
Postmission: Samples from the *massifs* (F2) were collected from large blocks suggesting consolidated source rocks. The *sculptured hills* yielded small samples grabbed off the surface, suggesting more friable rocks and explaining the dissected aspect. All *highland samples* were breccia with ages of 3.9 to 4 b.y. [7], corroborating that impact basins are ancient.

The *valley floor* (F2), littered with basalt blocks ejected from craters, confirmed that the *plains* were underlain by *mare basalt*, around 3.7 b.y. old [9] and about 1400 m thick [8], and overlain by unconsolidated regolith [8].

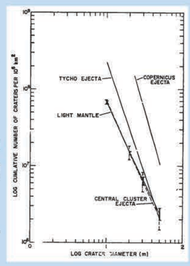
The *dark mantle* was not found. However, at the rim of the fresh crater Shorty (F7) the astronauts stumbled across *orange and black glass beads* [4]. Similar orange and black material ejected from small craters was observed from orbit in a dark mantle on the southwest side of the Serenitatis basin [10] (F6). The orange glass and underlying lava have similar ages of 3.7 b.y. [11]. Apparently a *layer of orange and dark glass* lies directly on top of the lava floor and was gardened into the regolith [12], giving it its low albedo. The most likely origin is from fire fountains [13]. The previous error in age assignment comes from the rapid degradation of young craters in the dark soil, giving an erroneously young age [14] (F4,5).

The light-mantle (F2) was indeed an avalanche dislodged from the South Massif. A study of rays and secondary craters from Tycho [15] (F8) strongly suggested that the *crater cluster* on the valley floor and a *cluster on top of the South Massif* were from Tycho, explaining both the avalanche and its ray-like aspect. Dating the event gave an age of 50-100 m. y. for the Tycho impact [15].

Conclusion: The geologic maps prepared for the Apollo 17 landing site are among the very few extra-terrestrial maps that were checked in the field. Overall, the premission geologic interpretations were correct but were refined by establishing compositions and ages for the sampled rocks. It was confirmed that most geologic processes on the Moon are ancient. A major error was the age assignment of the dark mantle, but it led to the realization that degradation rates of small craters (100-200 m) are highly sensitive to the strength of the target material.



Left: (F8) Comparison between Tycho secondary cluster (left image), and Ap 17 avalanche deposit (right image). Similarity in fine braided pattern with apex pointing toward Tycho suggests that the avalanche was dislodged by secondaries from Tycho hitting the South Massif (F2).



Right: (F9) Cumulative crater frequency curves of small craters on light mantle and central cluster. Apollo 17 curves fall near the Tycho curve. From [15].

References from abstract #1573:
[1] Scott D. H. and Carr M. H (1972) USGS Misc. Geol. Inv. Map I-800, sheet 1. [2] Lucchitta B. K. (1972) USGS Misc. Geol. Inv. Map I-800, sheet 2. [3] Lunar Sample Pre-lim. Exam. Team (1972) NASA SP-289, 6-1 – 6-25. [4] Muehlberger W. R. et. al. (1973) NASA SP-330, 6-1 – 6-91. [5] Soderblom L. A. and Lebofsky L. A. (1972) JGR, 77, 279-296. [6] Carr M. H. et al. (1966) USGS Misc. Geol. Inv. Map I-489. [7] Winzer S. R. et al. (1977) Earth Planet. Sci. Let., 33, 389-400. [8] Wolfe E. W. et al. (1975) LPSC VI, 2463-2482. [9] Papike J. J. et al. (1974) LPSC V, 2761-2782. [10] Lucchitta B. K. and Schmitt H. H. (1974) LPSC V, 223-234. [11] Hussain L. and Schaeffer O. A. (1973) Sci., 180, 1358-1360 [12] Pieters C. et al. (1974) Sci., 183, 1191-1194. [13] Heiken G. H. et al. (1974) Geochim. Chosmochim. Acta, 38, 1703-1718. [14] Lucchitta B. K. and Sanchez A. G. (1975) LPSC VI, 2427-2441. [15] Lucchitta B. K. (1977) Icarus, 30, 80-96. [16] Lucchitta B. K. (1976) LPSC VII, 2761-2782.

USGS
science for a changing world