STRATIGRAPHIC VARIATIONS BENEATH LUNAR MARE SURFACES AS INDICATED BY EJECTA CHARACTERISTICS OF 0.5 TO 2 KM CRATERS:

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The increasing evidence for the complex volcanic history of the lunar maria (1,2,3) and of the rapid decrease in impact flux prior to and during mare flooding (4) suggests the following: 1) the maria were almost certainly filled by a series of volcanic flows of different thicknesses and dimensions, 2) during this time interval some of the circular maria must have been undergoing tectonic adjustments and may at first have looked much like Mare Orientale, and 3) the rapidly decreasing impact flux probably formed variable thicknesses of regolith and ejecta deposits on each new extrusive sequence. The gradual filling of the lunar maria would have proceeded so that: 1) the lowest depressions within the maria were probably filled first, producing larger, more level, uniform surfaces for younger deposits, and 2) the later stages of filling were characterized, in part, by more extensive, thinner flows which could have covered increasingly wider regions. The filling of initially uneven areas over different time intervals by flows of varying thicknesses and areal dimensions would give rise to basically different stratigraphic sequences in different regions (within or between individual maria). Each mare region must therefore be underlain by a different sequence consisting of layered flows, ejecta from large impacts, and regolith zones formed between episodes of volcanism.

Postmare impacts which penetrated these different regional stratigraphic sequences should have produced exposures of layering in crater walls and ejecta deposits characteristic of each subsurface stratigraphic section. It appears that for craters larger than a few kilometers in diameter, the effect of the impact process on the "typical" mare stratigraphic sequence has been to homogenize the ejected debris to the extent that differences between crater ejecta blankets are not always obvious. In addition, the fractured nature of the crater wall materials makes tracing of individual layers for extended distances difficult. The uniformity of the ejecta deposits may be the result of impact penetration through many layers which are thin in comparison with the crater dimensions.

Recent Apollo panoramic photography (with resolution approaching 10 meters) provides the first extensive lunar coverage which permits uniform, detailed regional comparisons of crater ejecta characteristics for craters in the 0.5 to 2 km diameter size range (see Figure 1). Since these small craters represent penetrations of a smaller number of subsurface stratigraphic units, their ejecta deposits would be more likely to show differences resulting from excavation of only a few, possibly dissimilar near-surface units.

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Evidence supporting this hypothesis can be seen in the consistent differences among the ejecta deposits of small craters across Mare Imbrium and Mare Serenitatis. Generally speaking, small craters are conspicuously more blocky in southeastern Serenitatis than in southern Imbrium. Terrestrial explosion studies (5,6) suggest that blockiness may be greater either where impacts penetrate through surface flows and the energy produced is directed laterally into less coherent subsurface layers, or where surface flows are more conspicuously jointed.

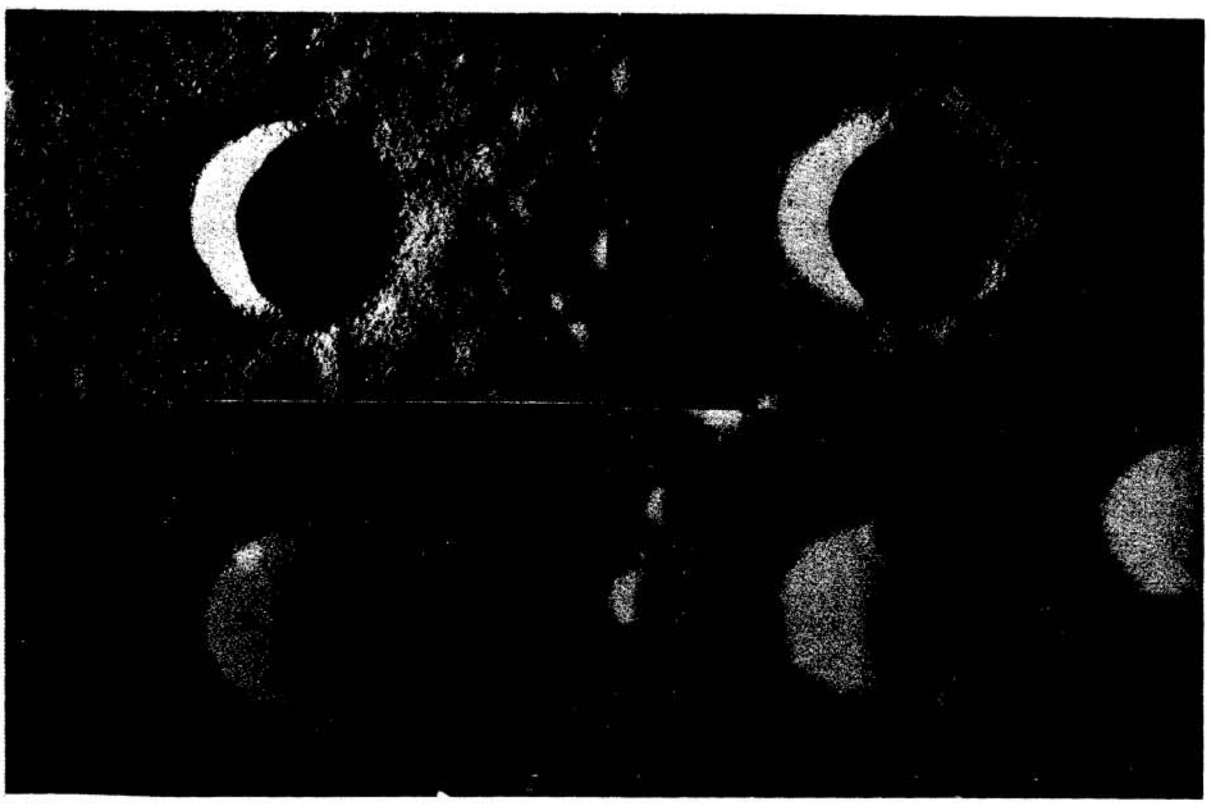

Figure 1 (A,B) Fresh and degraded 1 Km craters, Mare Serenitatis.
(C,D) Fresh and degraded 1 Km craters, Mare Imbrium.

As shown in Figure 1, 0.5 to 2 km craters on these two mare surfaces are quite dissimilar, and become degraded in different ways. The craters shown in these figures were chosen as typical examples of fresh and degraded impact craters which can easily be located in large numbers on panoramic photographs of the two basins.

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Another conclusion resulting from these observations is that conspicuous blockiness is not always produced by impacts in lava flows at or near the lunar surface. For example: craters in the Imbrium flows northeast of Lambert or near rilles such as Hadley and others (presumed to be collapsed lava tubes or channels which would indicate flows near the surface) are not as blocky as the craters on the older (more densely cratered) surface of southern Serenitatis. Portions of Serenitatis exhibit a greater blockiness for 0.5 to 2 km diameter craters in all stages of degradation.

Therefore, it appears that blockiness by itself is not a reliable criterion for crater age, for speculations on depth to rock, or for determining the volcanic vs. impact origins of small craters. Crater parameters are more likely to be a function of stratigraphic differences on a local or regional scale where impact penetration of 2 or more different units has occurred.

The comparison of crater characteristics in the 0.5 to 2 km size range may be a useful tool for delineating major near-surface stratigraphic variations across mare surfaces, which are not apparent from crater density distributions, or which might be masked by surface color changes related to minor surface events. Exposure of blocky (crystalline) material in the craters should provide suitable targets for earth-based, near-infrared spectral reflectance studies of subsurface mineralogical variations in the lunar maria (7).

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